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ESSAYS

ON

PRACTICAL MEDICINE AND SURGERY,

BY

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THE

AMERICAN CYCLOPEDIA

OF

PRACTICAL MEDICINE AND SURGERY.

ANGIODESIS, or ANGEIODESIS. (From αγγειον, a vessel, and δειξις, demonstration.) Distension or swelling of vessels. Condition near to inflammation, according to TOMMASINI. I. H.

ANGIOLEUCITIS, or ANGEIOLEUCITIS. (From αγγειον, a vessel, and λευκος, white.) Inflammation of the white vessels: Lymphatic or scrofulous inflammation: Subinflammation, of BROUSSAIS. I. H.

ANGIOSIS. (From αγγειον, a vessel.) ALIBERT has given this term to the sixth family, in his nosology, and which comprises all diseases seated in the blood-vessels. I. H.

ANGIOTENIC, or ANGEIOTENIC. (From αγγειον, a vessel, and τεινειν, to stretch.) PINEL invented this term to designate the condition of the blood-vessels in certain fevers. His order, angiotenic fevers, comprises all those which exhibit, besides fullness and tension of the vessels, symptoms of irritation of the arterial tunics: it is the *Synochus imputris*, GALEN; *Synocha simplex, et acuta sanguinea*, HOFFMAN; *Febris continens vel synocha*, STAHL; *Febris inflammatoria*, STOLL, &c.; *Synocha*, SAUVAGES, CULLEN, &c. (See *Fever.*) I. H.

ANGLE. (From αγκυλος, a hook.) The inclination or opening of two lines, having different directions and meeting in a point. In anatomy, the epithet angle is bestowed on certain parts of bones and large muscles; on the union of two branches of bones; on the commissures of the eyelids, and of the lips; on the union of the facial and basilar lines (*facial angle*, q. v.), &c. I. H.

ANGULAR. That which appertains to an angle. I. H.

ANGUSTURA BARK.—ANGUSTURA, Ph. U. S.—*Angusture*, Fr.; *Angustura-rinde*, Germ.

Botanical History. Nothing was certainly known of the source of this bark till the annunciation, by HUMBOLDT and BONPLAND, of their discovery of the tree producing it. These travellers, when at Angustura, a town upon the banks of the Orinoco, in South America, received a specimen of the leaves of a tree growing in that neighbourhood, from which the bark was said to be derived. A tree which they subsequently observed near Cumana, was believed by them to be the same, and, as it appeared to them not to belong to any known genus, was ascribed to a new one, which they named *Cusparia*, distinguishing the species by the title of *febrifuga*. A specimen of the plant was, in the mean time, sent to WILLDENOW, who also considered its generic characters as distinct, but named it, in honour of one of the celebrated travellers, *Bonplandia trifoliata*. This title was subsequently adopted by HUMBOLDT and BONPLAND, and has been recognized by the Edinburgh and Dublin Colleges as the name of the Angustura bark plant, while the London Pharmacopœia retains the original appellation of *Cusparia febrifuga*. MM. ST. HILAIRE and DE CANDOLLE, however, deny that the genus is distinct, and are probably correct in considering it as identical with *Galipea*. They have accordingly proposed for the plant the name of *Galipea Cusparia*, which has been adopted by some European writers. But, after all, there is reason to believe that the tree observed by HUMBOLDT and BONPLAND is different from that which produces the Angustura bark, though belonging to the same genus. These authors were probably led astray by the imperfect specimen which they received of the true plant. According to Dr. HANCOCK, who resided in the country where the Angustura bark is produced, the tree yielding it differs

strikingly in size from that described by Humboldt and Bonpland, the latter being sixty or eighty feet in height, while the former never exceeds twenty feet. For the genuine tree, Dr. Hancock proposes the name of *Galipea officinalis*; and this has been recognized in the last edition of the U. S. Pharmacopœia. There can be little doubt of the correctness of Dr. Hancock's statement. In relation to the size of the tree, his account is confirmed by the character of the bark found in the market, which could not have been derived from a large trunk.

The *Galipea officinalis* of Hancock belongs to the class and order *Diandria Monogynia*, and to the natural order *Diosmeæ* of Lindley's Introduction. It is a small branching tree, of the medium height of twelve or fifteen feet, with an erect stem from three to five inches in thickness. The leaves, which are alternate and petiolate, consist of three oblong leaflets, pointed at each end, from six to ten inches long, from two to four broad, smooth and glossy, of a bright green colour, of a strong odour when fresh, and supported upon short leafstalks. The flowers are numerous, and arranged in terminal and axillary peduncled racemes. They are white, and have a peculiar unpleasant odour. The calyx is bell-shaped, five-cleft, and inferior; the corolla about an inch long, composed of five unequal, oblong, obtuse, reflexed petals, united at the base; the stamens two, with five linear leaflets which may be regarded either as abortive stamens or nectaries. The fruit consists of five bivalve capsules, each containing two round black seeds, of the size of a pea. Two or three of the capsules, and one of the seeds in each capsule, are often abortive.

The tree grows in great abundance in the countries bordering upon the Orinoco river, at the distance of two hundred miles or more from the ocean. It prefers a rich soil, and flourishes at the height of between six hundred and one thousand feet above the level of the sea. According to Hancock, it is called by the aborigines, *Orayuri*; by the Spaniards and Creoles, *Cascarilla*, or *Quina de Carony*.

Sensible properties, composition, &c. Angustura bark is in pieces from two to eight inches long, or even longer, from half an inch to an inch and a half broad, from half a line to two or more lines in thickness, generally thinner at the edges in consequence of having been cut obliquely from the tree, usually somewhat rolled, seldom quilled, and sometimes nearly flat. The outer surface is covered with a light yellowish-gray epidermis, which is sometimes thick, soft, and spongy, so that it may be easily scraped with the nail. Occasionally, the epidermis is partially wanting, when the colour is brown. The inner surface is usually of a dull yellowish-fawn colour, more or less rough and splintery. The bark is brittle, with a short resinous fracture, and affords a pale yellow powder. The odour is peculiar, and rather disagreeable, becoming weaker by age. The taste is bitter and slightly aromatic, leaving a sense of pungency at the end of the tongue. The constituents of the bark, according to Fischer, are volatile oil, bitter extractive, a hard and bitter resin, a soft resin, a substance analogous to caoutchouc, gum, lignin, and salts. The active principles are probably the volatile oil and bitter extractive. The bark yields its virtues both to water and alcohol.

Medical properties and therapeutic application. Angustura bark is a stimulant tonic, capable, when given in large doses, of producing an emetic and cathartic effect. It has long been employed in South America, but was not brought to Europe till the year 1778, when a portion of it reached England from the West Indies, into which its use had been introduced from the neighbouring continent. It attracted considerable attention from physicians, and the reports in its favour were such, that it soon became officinal throughout Europe and America. Its virtues were supposed to be the same with those of Peruvian bark; and it was particularly recommended in intermittent fever, bilious diarrhœa, and obstinate dysentery. It was also found useful in dyspepsia, and other complaints attended with weakened digestion or general debility. But the favourable results of the first trials have not been fully confirmed by subsequent experience. The remedy has repeatedly failed in the cure of intermittent fever; and, in other cases in which tonics are indicated, has not been found superior to the medicines previously in use. It has, therefore, of late, been very much neglected, and in this country is seldom prescribed. It may, perhaps, be more efficacious in the complaints of tropical latitudes than in those which prevail in temperate regions. Dr. Hancock speaks in the strongest terms of its efficacy in numerous cases of malignant bilious fever, dysentery, and dropsy, which came under his notice in Angustura and Demarara. He found it, in these complaints, greatly superior to

Peruvian bark. It is asserted to have this advantage over the latter remedy, that it is less apt to oppress the stomach.

Dose and preparations. The bark may be administered in powder, infusion, tincture, or extract. The dose of the powder is from ten to thirty grains, repeated every three or four hours through the day. In larger quantities, it is apt to produce nausea. The extract may be given in the dose of from five to fifteen grains, but is said to be inferior to the powder or infusion. The latter is prepared by macerating half an ounce of the bruised bark in a pint of boiling water (Ph. U. S.), and may be given in the quantity of a wine-glass-full, repeated several times a day. The dose of the tincture, which is officinal, is one or two fluidrachms.

Dr. Hancock employed a fermented infusion prepared nearly in the manner directed by the native doctors. Into a jug, containing about six gallons, he put a pound of the coarsely powdered bark, the same quantity of brown sugar, and about four ounces of wheaten bread to hasten the fermentation; then filled the vessel nearly with boiling water, stopped it closely, and placed it in the sun, taking care that it should be frequently shaken. So soon as fermentation had well commenced, the preparation was considered fit for use, and given in the quantity of from four to six ounces, three or four times a day.

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Geo. B. Wood.

ANGUSTURA BARK (False).

Under the name of *false* or *ferruginous Angústura*, a bark has recently attracted some attention in Europe, on account of its poisonous properties. It is said to be taken to that continent mixed with the genuine, and to have been sometimes administered for it by mistake, with dangerous and even fatal effects. I have never met with it in the parcels of Angustura which have come under my notice in this country; yet it is important to be acquainted with its distinguishing properties, in order to be guarded against the danger of its possible introduction into our shops. When first noticed, it was supposed to be the product of the *Brucea antidysenterica*, and was afterwards referred to the *Strychnos colubrina;* but the former is an Abyssinian, the latter an East India tree; while the bark is now known to be derived from South America. Its precise source is entirely unknown.

The false Angustura bark is thicker, harder, heavier, and more compact than the genuine; its external surface, or epidermis, is destitute of lichens, which are frequently found on the other, and is either covered with a rust-coloured efflorescence, whence the name of *ferruginous Angustura* was derived, or presents a yellowish-gray colour with numerous elevated whitish spots; its internal surface is smooth; its fracture dull and brownish, and wholly destitute of a resinous appearance; its powder is yellowish-white; it is destitute of odour; and its taste, though excessively bitter, and in this respect much exceeding that of the genuine, is neither pungent nor aromatic. Nitric acid produces a blood-red colour when dropped upon the internal surface of the spurious bark, and an emerald-green colour upon the epidermis or efflorescence on the external surface, while it yields a dull red on both surfaces of the true.

Pelletier and Caventou discovered in the false Angustura a peculiar alkaline principle denominated *brucia*, which has been subsequently found in the nux vomica and bean of St. Ignatius. (See *Nux vomica.*) Upon this principle, the poisonous properties of the bark depend.

From the experiments of Orfila and others, it appears that the false Angustura, administered to animals, in the form of powder or extract, acts in the same manner as the nux vomica, producing violent tetanic convulsions, which speedily end in death. Eight grains of the bark, given to a dog of middle size, proved fatal in the course of an hour and a quarter. The same effect resulted from the introduction of the powder or extract into the cellular membrane of the thigh. Dissection revealed no marks of inflammation, and the poison was supposed to act upon the nervous system, and principally upon the spinal marrow. Emmert relates a case in which the bark was administered as a tonic, to an infant, by mistake for the genuine Angustura, and occasioned death, with frightful convulsions. It is not employed as a medicine, although, from the resemblance of its action to that of nux

vomica, it might probably be serviceably and safely applied to similar cases, if its dose were accurately ascertained. A case is related in the *Journ. Univ. des Sciences Méd.* IX. 118., in which twelve grains of the bark, given twice a day, to a patient affected with obstinate intermittent frontal neuralgia, produced a cure, though not without dangerous evidences of its powerful action, such as vertigo, and convulsive tetanic movements.

GEO. B. WOOD.

ANHELATION. (From *anhelo*, I pant.) *Anhelatio*, Lat.; *Essouflement*, Fr. Short and difficult respiration. (See *Dyspnœa.*) SAUVAGE has made this the character of one of his classes of diseases. This term has sometimes been employed synonymously with *Asthma* (q. v.). I. H.

ANHISTOUS. (From α priv. and ιστος, tissue.) *Anhiste*, Fr. Without texture.

Anhistous membrane. This term has been given by M. VELPEAU to the membrana decidua. *Embryologie*, p. 7. (See *Ovum.*) I. H.

ANHYDROUS. (From α priv. and ὑδωρ, water.) Containing no water. Those salts are termed anhydrous which contain no water of crystallization. I. H.

ANIMAL CONTAGION. (See *Contagion.*)

ANIMAL HEAT. (See *Calorification.*)

ANIMALCULAR. Appertaining to animals. I. H.

ANIMALCULE. (Diminutive of animal.) An animal perceptible only with the aid of a microscope. I. H.

ANIMALITY. The attributes and properties of animal organic matter.

I. H.

ANIMALIZATION. The conversion of vegetable substances into animal matter. It is the compound product of several successive elaborations of matters destined for nutrition, effected in the animal economy, before they are assimilated and applied to the reparation of the body. (See *Digestion, Assimilation,* and *Nutrition.*) I. H.

ANIME.—*Gum Anime.*—*Animée*, Fr.; *Anime*, Germ.

The substance known by this name is a resinous product, brought from South America, and generally supposed to be derived from the *Hymenæa Courbaril*, though this origin is not undisputed. It is in small irregular pieces, of a pale yellow colour sometimes inclining to reddish, more or less transparent, brittle and pulverizable, of a shining fracture, of a weak agreeable odour rendered stronger by heat, and of a mild resinous taste. It softens in the mouth, adheres to the fingers when in the state of powder, and melts with a moderate heat. It consists of two distinct resins, one soluble, the other insoluble, in cold alcohol, and of a small proportion of volatile oil. Other varieties of Anime are described in the books, but are at present scarcely known in commerce. This resin was formerly employed in pharmacy as an ingredient of ointments and plasters; but is at present used only as incense, and in the preparation of varnishes. It is said to be employed internally, in Brazil, in complaints of the lungs. GEO. B. WOOD.

ANIMISM. (From *anima*, the soul.) This epithet has been usually employed to designate the doctrine of STAHL, who referred all the phenomena of the animal economy to the soul. But it has been very justly observed by M. DEZEIMERIS, that we ought to understand by that term, every physiological doctrine which, to explain the phenomena of life, supposes the existence, in organized bodies, considered as inert, of a principle of action, existing of itself, and whose office it is to animate them. It is wrong, then, to restrict this term to designate the doctrine of STAHL; it is doubly erroneous, for, on the one hand, Stahlianism, considered relative to its hypothesis of the first causes of life, is but a particular form of animism; and animism, on the other hand, is far from embracing entirely, the comprehensive doctrine of the professor of Halle. (See *Vitalism.*) I. H.

ANISE, or ANISEED. (*Mat. Med.*) ANISUM, U. S. Ph.; *Anis*, Fr., Germ.

Aniseed is the product of an annua plant (*Pimpinella anisum*) indigenous to the countries bordering on the Mediterranean, and which is cultivated in many parts of Europe. Several kinds are found in commerce: 1. that from Russia, which is small, blackish, acrid, and but little esteemed: 2. that from Touraine, which is green, and much milder: 3. that from Albi, which is lighter coloured, and more aromatic: and, 4. that from Spain and Malta; this is the variety generally met with in the shops. It consists of small oblong striated capsules, of an ash-green colour, and containing two seeds, attached to each other by a flat surface. They possess an aromatic and pleasant taste, and a fragrant odour. These properties depend on a volatile oil which appears to reside in the integuments, in the proportion of about one ounce of oil to three pounds of seed. This oil, which is obtained by distillation, is transparent, and concretes at 59° F. It imparts its sensible properties to boiling water, though sparingly, but is

readily soluble in alcohol. By expression, a fixed oil is also obtained, which is a mixture of a mild, inodorous fat oil, with a small portion of the volatile oil just spoken of.

Aniseed is much employed in Europe, as an aromatic carminative, more especially in domestic practice, in flatulent colic, and as a corrective of the griping occasioned by many of the drastic purgatives. In this country, less use is made of it, its place being supplied by more efficient articles.

It may be given, in substance, in doses of twenty or thirty grains, or in infusion; this latter form, however, should be discarded, as inefficient. The neatest mode of administration is the volatile oil, of which the dose is from five to ten drops. It should be noticed that much of the oil of aniseed of our shops, is the product of the *Illicium anisatum* (q. v.), and is superior to that of the *Pimpinella.*

The principal consumption of aniseed is in domestic economy, to flavour confectionary and cordials.

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R. E. Griffith.

ANKLE. The surgical acceptation of this term has never been very accurately defined. In ordinary language, it is sometimes employed as synonymous with malleolus, and, at others, it is applied more generally, to the articulation between the bones of the leg and the astragalus. The latter application appears to be adopted by many surgeons, while others give still greater extension to its signification. It seems to us almost a matter of necessity to include under this head all those parts which are immediately connected with the several motions performed by the foot, viewed in its totality, upon the leg; for, otherwise, it is extremely difficult to give a clear account of many of the accidents and injuries involving what is universally called the ankle joint.

The ankle, then, viewed as a region, includes the two malleoli, with so much of the lower extremities of the tibia and fibula as are interested in the inferior articulation of those bones; the astragalus and its several articulations with the leg, the os calcis, and the os scaphoides; the ligaments of all these articulations; and the various soft parts that surround the limb between the superior surface of the os calcis, the posterior edge of the os scaphoides, and the summit of the parts accessory to the lower articulation of the tibia and fibula.

With the soft parts last mentioned, we have little concern in the present article; the details of their anatomy will be found in the appropriate general articles; and the accidents and diseases to which they are liable will be described under the same or other heads. (See *Tendon*, *Bursa Mucosa*, *Artery*, &c.) Many of the affections of the joints and bones, not in their nature peculiar to the ankle, are also referred to the articles on *Bones*, *Necrosis*, &c.

Art. I. Surgical Anatomy of the Ankle. Referring elsewhere for most of the details relating to the bones and ligaments which form the ankle and its articulations (see *Bones*, and *Articulations*), we propose to confine ourselves, in the present article, to a rapid view of some important generalities which form a necessary introduction to the subjects which we shall have presently to discuss.

The inferior articulation of the fibula with the tibia, is scarcely capable of any motion; yet it is provided with articular cartilages, lined by a production in cul de sac of the synovial membrane of the ankle joint. Numerous and powerful ligaments connect the opposite bones with each other, so that in severe injuries the ligaments are rarely ruptured; for the fibula is frequently broken by forces too slight to tear them, and sometimes the tibia itself gives way before the articular connexions yield, leaving a portion of its lower extremity still attached to the fibula. The internal side of the fibula is here somewhat convex, and is received into a slight longitudinal groove in the external side of the lower extremity of the tibia, which structure gives material protection to the articulation against injury in violent rotations of the foot.

The deep hinge-like cavity for the reception of the articular pulley of the astragalus is thus formed. The superior face of the pulley is directly opposed to the inferior extremity of the tibia. A process from the latter, called the internal malleolus, is continued downward for some distance, and stands opposed to the internal lateral face of the pulley. The fibula is continued downward for some distance below its inferior articulation with the tibia, and is enlarged at the same time into a kind of head called the external malleolus. The greater part of the internal surface of this malleolus stands opposed to the external side of the pulley of the

astragalus; the remainder is prolonged downward and somewhat backward, into a kind of hook for the protection of a tendon; and this prolongation may be brought into contact with the external face of the os calcis, in violent abductions of the foot. The external descends much lower than the internal malleolus, and it is also situated further back. The cavity for the reception of the pulley is considerably enlarged in rear by the posterior transverse ligament of the ankle joint, a band of very strong arched fibres stretching from one malleolus to the other along the posterior margin of the inferior extremity of the tibia. Into this complex cavity the pulley of the astragalus is received, and all the opposing surfaces of the bones are covered with articular cartilages. The joint is secured by numerous ligaments, and has one synovial membrane common to the whole of this and the preceding articulations. In order to comprehend all the motions of the foot upon the leg, it must be remembered that the pulley of the astragalus is considerably narrower behind than it is before; hence, when the foot is flexed, the articular cavity is completely filled by it, and the motion of the joint is reduced to a simple flexion and extension; but when the foot is extended, the cavity is not so fully occupied, and some slight lateral motion of the astragalus may take place. The interlocking between the groove in the upper face of the pulley of the astragalus, and the corresponding ridge of the tibia, together with the tonic contraction of the powerful muscles of the foot, and the position of the ligaments of the articulation, deprive the joint of all voluntary motion except that of a simple hinge; and it is only under the action of accidental forces, that it assists in the lateral or rotatory movements of the foot.

The ligaments of the ankle joint are all highly important in a surgical point of view, and their connexions must be carefully studied by those who would perfectly comprehend the accidents to which the joint is subject.

The astragalus rides upon the os calcis, and fills the cavity of the os naviculare, between which bones, and those of the leg, it acts somewhat in the manner of a friction wheel, as we shall see hereafter. On its lower or plantar face, we observe a very deep groove, commencing near the posterior end of its internal margin, and passing forward and a little outward, so as to divide its lower articular surface into two nearly equal parts. Directly beneath this, is a similar groove on the upper face of the os calcis, which, with the former, completes an irregularly elliptical canal, beginning below the posterior edge of the internal malleolus, and terminating a little behind, and beneath the middle of, the anterior margin of the articular pulley. This canal is filled by a very powerful *interosseous ligament*, which is never completely ruptured except under the action of tremendous forces.

Behind and on the outside of the interosseous ligament, we find the posterior or external articulation, between the astragalus and the os calcis. It is arthrodial in character, the head being formed by the latter bone, and presenting upwards and forwards. The excavation in the astragalus which receives this head is of a lunated shape, and is surrounded by a rather sharp edge which posteriorly is particularly well defined. Its centre corresponds with the level of the apex of the internal malleolus. This joint enjoys an antero-posterior motion in walking, in which case the astragalus moves upon the os calcis; a lateral motion in the adduction and abduction of the foot, during which the former bone remains at rest; and a very slight degree of rotation. A proper synovial membrane is exclusively provided for this articulation, which derives its strength chiefly from the interosseous ligament noticed above.

The articulation of the head of the astragalus with the tarsus, is an enarthrosis. The cavity of the joint is formed, behind, by the lunated cavity of the os calcis, for its anterior or internal articulation with the former bone; before, by the concavity of the posterior face of the os scaphoides; and beneath, by the two calcaneo-scaphoid ligaments.

All the parts interested in this articulation are lined by a common synovial membrane. The motions of the joint, like all those of a similar structure, are limited in extent only, and not in direction; in conjunction with the posterior articulation between the astragalus and os calcis, it permits the adduction, abduction, and rotation of the whole foot on the leg; in conjunction with the articulation between the os calcis and the cuboid bone, it enjoys other powers, unconnected with our present subject (see *Foot*); but it also contributes slightly to the flexion and extension of the foot, and this fact is of high surgical importance, as will be elsewhere noticed.

Art. II. Mechanism of the Injuries of the Ankle. Most of the peculiar injuries of the ankle joint result from undue and violent extension of some of the na-

tural motions of the part. They may be enumerated in the order of their importance, as follows: Sprains, or contortions of the ankle; diastasis of the inferior articulation of the tibia and fibula; fractures of the bones of the leg, involving the ankle joint, or influencing its functions; and dislocations of the foot. Until recently, the mechanism of these accidents has been very imperfectly described; and it is indispensably necessary that the nature of the several motions of the foot should be fully understood, in order to their proper comprehension.

When all the muscles of the foot are in a state of relaxation, as in sleep, the tonicity of the extensors and adductors overcomes that of the flexors and abductors, so that the toes point downward, and the sole of the foot is turned a little inward; but the abductors are inserted at a greater distance from the centre of the joint than their antagonists, and thus enjoy a mechanical advantage which, when they are called into action, gives the foot a tendency to evertion. This would render the joint extremely liable to injury, were it not for the resistance of the elongated external malleolus, which furnishes the necessary counteracting force by its pressure upon the side of the astragalus. The toes are naturally pointed outward, in consequence of the position of the external, in rear of the internal malleolus; but if all the intertarsal articulations remain fixed, the natural invertion or additional evertion of the toes is limited to an exceedingly slight rotation, performed by the astragalus, and permitted by the scarcely perceptible mobility of the lower articulation between the tibia and fibula. Even the articular connexions of the astragalus with the other tarsal bones, cannot materially facilitate the invertion or evertion of the toes, unless the sole of the foot is permitted, at the same time, to present itself inwardly or outwardly; because the astragalus cannot rotate itself upon the ossa calcis and naviculare horizontally, or around a perpendicular axis; for all its movements upon the tarsus, except those of simple flexion and extension of the foot, are orbicular and complex. If, then, the whole foot becomes suddenly fixed, and the leg is at the same time forcibly twisted, or vice versâ, the chief part of the force is exerted in turning the pulley of the astragalus within the ankle joint. Now this must evidently tend to throw the malleoli asunder, and will produce a sprain of the ankle, and of the tibio-fibular articulation; a diastasis of the latter; or a fracture of one or both malleoli, with consecutive dislocation of the foot; according to the nature and violence of the force applied.

When the weight of the body rests upon the feet, it is the outer side of the tarsus, and the tuberosity of the os calcis, only, that approach the soil; the remainder of the dome, and the inner side of the arch of the tarsus, remain considerably elevated, and the whole support of the foot, on this side, depends upon the ball of the great toe. Now, if a line be drawn from the tuberosity of the os calcis where it rests upon the ground, to the ball of the great toe, subtending the plantar arch, it will be found to fall very considerably to the outside of the middle line of the ankle joint, so that the joint overhangs the base on which the foot is supported upon the inner side. It follows from this position, that the weight of the body tends constantly to bring the inner edge of the foot toward the ground, or to produce abduction; a tendency considerably increased by the oblique position of the leg, which inclines inward from the knee to the ankle. If the internal lateral ligament were left to oppose this disposition to abduction, without additional aid, the protection to the joint would be very inefficient; but the elongation of the external malleolus secures the astragalus in its proper position, in all the ordinary attitudes of the body. On the contrary, when, in falls from a height, upon a plane surface, or in sudden missteps, the momentum of the body is substituted for its simple weight, the abduction of the foot is often carried beyond its natural limits, and gives rise to accidents, grave in proportion to the extent of the fall and the position of the body at the moment.

In the healthy condition of the parts, the lateral motions of the foot are performed independently of the astragalus, which retains constantly the same position, if we except a very slight rocking motion permitted by the yielding of the ligaments. Adduction and abduction are chiefly accomplished by the double articulation of the astragalus with the os calcis and os scaphoides: the nature of the motion will be easily understood by reference to the skeleton, though it hardly admits of description. The anterior part of the foot may be rotated much further than the posterior, in consequence of the complex motions of the various bones of the tarsus and metatarsus (see *Foot*); but these motions are foreign to the present article. The natural extent of abduction is more

limited than that of adduction. When forcibly carried beyond its proper limits, the first effects are as follows: The internal lateral, or deltoid ligament, is put upon the stretch; the head of the astragalus sinks deeply into the socket, pressing down, or flattening, the arch of the tarsus, and tending strongly inward against the lateral portion of the inferior calcaneo-scaphoid ligament; while the cuboid and scaphoid bones, following the motions of the front part of the foot, are rotated somewhat upward, so as to become prominent on the back of the foot. As the head of the astragalus cannot become primarily dislocated inward or downward, in consequence of the great strength of the ligament just mentioned, the abduction cannot be carried any further by the inferior articulations of the astragalus, and the abducting force then tends to twist or to evert the whole of this bone in the ankle joint, causing it to react strongly on the external malleolus, and putting upon the stretch the ligaments of the inferior tibio-fibular articulation. This accident may produce severe sprains in the ankle proper, in the joint last mentioned, and in the articulation between the astragalus and the os scaphoides: all the other joints of the tarsus partake more or less in the injury when the case is serious.

In falls from a great height, the mischief does not stop here. The astragalus is forced still further from its erect position; the deltoid ligament is partially or completely torn or separated from its attachments; or, as sometimes happens, this very firm band of fibres tears off the internal malleolus. The momentum of the body now acts with great force upon the external malleolus, which descends upon the side of the astragalus, comes in contact with the os calcis, and is forced violently outward. The ligaments of the tibio-fibular articulation may yield in some very rare cases, and a diastasis of this joint is the consequence. One instance is recorded by Boyer, in which there was a complete separation of the fibula at both extremities. (*Mal. Ch.* IV. 375.) More frequently, the ligaments just mentioned tear off a portion of the tibia, which remains attached to the lower extremity of the fibula (see Sir A. Cooper, *on Fractures and Luxations*); but a much more common result is a fracture of the latter bone above the joint, at some point within three inches of its extremity. This fracture generally results from an increase of the natural curvature of the bone, produced by the pressure acting upon the malleolus. Even when the tibia and fibula are not separated, this accident produces an unnatural tendency to abduction of the foot, from the mobility of the lower fragment of the fibula, and the consequent loss of proper lateral support from the malleolus: a partial luxation is the result, which will continually recur unless proper mechanical measures are employed to prevent it. This may be regarded as a sprain of the ankle complicated with fracture of the fibula. The same state of things often occurs without a sprain, when the fibula is broken by direct external force near the ankle joint. But even when diastasis, or partial fracture of the tibia, occasions a separation of the bones, the fibula must be generally broken consecutively, because the external malleolus is still driven outwards, while the body of the bone is kept in proximity to the tibia by the interosseous ligament of the leg, which exceeds the bone in its powers of resistance. Under such circumstances, a luxation of the foot is the inevitable consequence. The farther complications and treatment of this accident will be mentioned when we reach the subject of luxations of the foot.

If, in such falls as we have been considering, the foot impinges upon an uneven surface, which happens so to support the inner edge of the tarsus as to prevent the abduction, the force is chiefly expended upon the horizontal articular surface of the tibia, and the lower extremity of this bone may be fractured or comminuted. The pulley of the astragalus, driving before it the fragments of the tibia, then ascends between the bones of the leg, and may produce a variety of accidents, according to the direction of the force applied. The fibula may yield at the same time, near its lower extremity, so as to produce what has been called luxation outward and upward.

I have seen the fibula ruptured three inches, and the tibia two inches above the ankle, the lower extremity of the latter being comminuted on its outer side; yet, from the size and interlocking of the internal fragment, and the integrity of the lateral ligaments, the derangement of the foot was very slight, and the only permanent deformity was a trivial shortening of the limb. The man died of fever, seven weeks after the accident, and a preparation was made of the part. The articulation between the bones of the leg retained its integrity in a great degree, for the lower interosseous ligament preserved its attachment to the fragment of the tibia, but the central portion of the lower

extremity of that bone was driven into the cancellated structure, with its cartilaginous covering.

Invertion or adduction of the foot is effected by the motions of the os calcis and the os naviculare, upon the astragalus. It is more extensive than the abduction. We have already mentioned the position assumed by the foot when the muscles are perfectly relaxed. When persons are habitually careless in walking, this state of relaxation is very apt to occur, and the consequences are often serious. The outer edge of the foot presents downward, and is thrown so far inward that the centre of the ankle joint overhangs it upon the outer side. If an inadvertent step be taken in this position, the whole weight of the body tends to increase the adduction, and carries it far beyond its natural limits. The entire tarsus rotates strongly inwards, the os naviculare sinks from its proper level, and the head of the astragalus becomes very prominent upon the dorsal surface of the foot. The interosseous ligament between this bone and the os calcis is forcibly stretched, and the injury it sometimes sustains is one of the most important consequences of the accident. As this ligament is immensely powerful, it soon puts a check to the motion of the astragalus upon the os naviculare, and prevents it from luxating upward. The action of the weight of the body is then transferred to the ankle joint; the lower surface of the astragalus endeavours to follow the os calcis, and the upper face of the pulley is directed outward. The external lateral ligaments are unduly stretched, and great pressure is exerted on the internal condyle. Hence result severe sprains of the ankle joint, (which, however, do not involve the tibio-fibular articulation,) and severe injury to the interosseous ligament of the calcis and astragalus, which sometimes gives rise to white swelling and anchylosis. If the force exerted is very great, the internal malleolus may give way, and the fibula may be broken by the traction of the three peroneo-tarsal ligaments; for the strength of these bands is so great that they are scarcely ever ruptured, but the malleolus is obliged to follow them in their displacement. Under these circumstances, the foot is inevitably dislocated. The worst cases of this character occur in falls from a height, when the foot is suddenly arrested, and the body inclines toward the opposite side, without receiving the support of the other foot.

In accidents producing forcible flexion of the foot, the front edge of the extremity of the tibia comes into contact with the neck of the astragalus, before the posterior edge has reached the summit of the pulley; hence, a dislocation of the foot forward is rendered extremely difficult, if not impossible. Moreover, the articulations of the astragalus with the other tarsal bones, are arranged in such a manner that this bone has very little tendency to become displaced backward upon the os calcis; on the contrary, it is pressed forcibly downwards; and if the force of the fall is very great, the tibia will yield before any other very serious consequence results.

The forcible extension of the foot is productive of more complex, as well as more serious, consequences. These might be explained, *à priori*, by a thorough anatomist well versed in the application of the known laws of mechanics; but they have received additional elucidation from the experiments of Dr. ROGNETTA. (*Archives Générales*, Dec. 1833.) When the extension begins to pass the natural boundary of motion, the anterior ligament of the ankle is distended, and a sprain of this joint is the consequence. The head of the astragalus rises in its socket, at the same time, and the interosseous ligament is extended, producing a sprain of this part also. If the extension is still continued, the posterior edge of the inferior extremity of the tibia approaches the lower edge of the astragalus; the pulley ruptures the front part of the capsular and anterior ligaments, and becomes partially luxated forward. If carried yet further, the external malleolus descends upon the outer face of the posterior part of the os calcis, where it is driven outward with so much force as to produce a sprain, and sometimes a diastasis of its articulation with the tibia, and, consecutively, a fracture of the bone itself, somewhere within three inches of the malleolus. If the force is still unexpended, the tibia continues to act as a lever upon the astragalus, its posterior edge urging the back part of this bone forward upon the os calcis, while the remains of its anterior, and part of its deltoid ligaments, elevate the head of the bone until the resistance of the interosseous ligament is partially overcome; the weak astragalo-scaphoid ligament gives way, and the head of the astragalus is dislocated upward and forward on the back of the tarsus. A slight lateral force is now sufficient to carry the head of the bone inward or outward, toward either edge of the foot, so as to produce consecutive dislocations of the astragalus, which cannot

under any circumstances occur primarily. The interosseous ligament is never completely broken in these accidents, unless the momentum of the body is added to the simple lever-like action of the tibia. In falls from a height, when the foot is completely arrested, it sometimes happens that the tibia slides forward over the articular pulley, and the foot is partially or completely dislocated backward, the astragalus remaining *in situ*. When this rare consequence does not follow, the impulsion of the body is transmitted to the last mentioned bone, which is chased forward by the tibia, until, after the complete separation of the interosseous ligament, it is entirely disembedded. (See *Astragalus.*) It should be borne in mind that in all cases of ruptures, so called, of the various ligaments in the experiments of Dupuytren and Rognetta, these bands were torn from their attachments to the bones, and were not divided through the fibres themselves.

The articulations about the ankle may be injured in various ways, by direct forces, unattended with falls from a height, or errors of position in walking—also by the simple force of the muscles, in dancing and other feats of agility. The latter causes of accidents are most liable to produce mischief in the practised votaries of Terpsichore, whose joints acquire, by habit, an extent of mobility inconsistent with strength and safety; but nearly every injury of the ankle may be reduced to one or the other classes of accidents already described, and their mechanism has been sufficiently developed.

Art. III. Sprains of the Ankle. These occur more frequently than similar injuries of any other joint, and the mischief that results is often very severe. In addition to the distension and partial rupture of the articular ligaments, there are other causes of evil, not so immediately connected with the joints. At the moment of the accident, some, or all, of the muscles of the foot are called into spasmodic action. The strongest of these are connected with long and powerful tendons, which are bound down, in the neighbourhood of the joints, by their thecæ and what is termed the annular ligament, which are intimately connected with the fascia of the leg, and are strongly attached, laterally, to the two malleoli. (See Blandin. *Traité d'Anat. Topograph.* p. 649.) The violent action of the muscles frequently occasions a disruption of some part of this apparatus, and of the numerous small blood-vessels that pass between the aponeurotic fibres; hence, severe injury to the soft parts, and extensive ecchymoses.

The first symptoms of a sprain are a severe pain in the injured part, with an inability to exercise the proper functions of the joint; the suffering being most intense when the foot is carried in the direction in which it was originally displaced. The irritation of the accident soon produces a great flux of the fluids toward the seat of injury. If the aponeurosis or any of its processes are ruptured, blood is effused into the cellular tissue, and the vital activity of the neighbouring parts being increased, inflammation supervenes, to a greater or less extent. In slight cases, these symptoms subside in a few days, without any unpleasant consequences; but in those of greater severity, particularly if any ligaments are violently twisted or torn from their attachments, active treatment is frequently required; and hydrops articuli, enlargements of the neighbouring bursæ mucosæ, false anchylosis, or, in scrofulous patients, white swelling, may be induced, in the face of all precautions.

Sprains from adduction are the most frequent, and generally occur from habitual carelessness in walking. The mischief, in these cases, is always extended to the articulations between the astragalus and the other bones of the tarsus; for the fibula is only broken by the traction of the lateral ligaments in this motion of the foot, and these act at so great a mechanical disadvantage, that the bone effectually resists very considerable forces. The short, strong, and oblique, internal malleolus, also, opposes a great obstacle to the lateral motion of the astragalus. The ankle joint thus guarded, the tarsal joints are subjected to violent torsion before the former articulation is seriously involved. The interosseous ligament suffers most in severe cases, and is the ordinary seat of the white swelling of the ankle.

Sprains from abduction are less frequent, for several reasons; first, because when one foot is turned upon its inner edge, the other is, generally, immediately employed in supporting the body; which at once arrests the abduction; secondly, because the extent of natural motion in this direction is less considerable, and therefore better guarded, according to the general law of all articulations, that the greater the extent of motion, the greater is the facility of injury; and thirdly, because the weakness of the fibula, which is subjected to direct pressure in this accident, permits it to yield to forces com-

paratively slight, so that severe injuries of this character are more likely to produce fracture of that bone, and luxation of the foot, than simple contortion of the joints. For the latter reason, also, the interosseous ligament of the os calcis and astragalus is less likely to suffer in violent abductions, than where the foot is moved in the opposite direction. The chief injury is seated about the inner malleolus, and the deltoid, or internal lateral ligament, is sometimes torn from its connexions. The experiments of M. Dupuytren appear to prove that this ligament is always separated from its attachments before the fibula is fractured by abductions; but we are inclined to doubt the absolute certainty of experiments performed upon the dead body, nor can we conceive how this broad band of fibres can be entirely detached, without such a change in the position of the astragalus as must produce fracture of the fibula, under the ordinary circumstances attending the accident in the living subject. That portion of the ligament which is attached to the os calcis passes over two articulations; it must therefore undergo a greater degree of extension, and may probably yield, before the fracture of the bone takes place.

Sprains from extension of the foot are serious, because, when severe, they are attended with a detachment of the anterior ligament of the ankle joint, and rupture of the synovial membrane, as well as a distension of the interosseous ligament; they therefore partake of some of the characters of a partial dislocation complicated with a sprain of at least two important articulations. It is probable, however, that the injury to the last-named ligament is seldom very important until the fibula is ruptured and the character of the accident changed.

Treatment. The immediate application of cold, in these, as in other sprains, is the most powerful of all measures for relieving the ill effects of the injury. For this purpose, the foot may be immersed in cold spring or ice water; or, what is still better, a stream of cold water, from a pump, hydrant, kettle, or any suitable vessel, may be allowed to fall from a height, upon the injured part. The last method is interdicted in cases of severe superficial injury, for the force of the water may prove injurious. On the first application of cold, the pain is almost always increased in severity; but, after a time, the sensibility of the part is diminished, and the foot becomes completely benumbed. The application should never be arrested until this last effect is produced; otherwise, the reaction which immediately follows, increases the swelling and inflammation. Respect should be paid to the general health of the patient, in prescribing this remedy, as, in catarrhal and consumptive cases, &c., it may be inadmissible. The effect of the cold is greater, the earlier it is employed; and in very severe sprains, after the swelling and inflammation have supervened, it may exacerbate the symptoms, by diminishing too much the vital energy of the lacerated and debilitated parts. Inflammation, if considerable, is to be combated by free leeching, lead-water, &c.; and emollient applications, such as poultices, and even warm ablutions, are often very serviceable. When the inflammation has subsided, the energy of the part may be sustained, and the absorption of the ecchymoses facilitated, by resolvent and gently stimulating embrocations, among the best of which is brandy, pure or diluted. Much benefit sometimes results from the pressure of a roller well applied, in the decline of the case. When chronic inflammation of the ligaments continues long, and threatens to produce serious evil, blisters and other counter irritants are applied externally; but it is highly important to remember that the direct irritation of these remedies may increase the evil, if they are placed immediately over the injured parts, when these are superficial. Hence, in sprains of the ankle proper, they should not surround the malleoli, nor the front of the articular pulley; and when the interosseous ligament is the seat of disease, they should not cover the rear of the internal malleolus. Throughout the whole treatment, attention to the motions of the foot, and its position, is indispensable. Until all inflammatory symptoms have ceased, absolute rest should be enjoined, and especial measures should be taken to prevent any renewal of motion in the direction that originally produced the injury. The foot should be placed and retained in an elevated position. Partial or complete anchylosis, hydrops articuli, ganglia, ruptures of tendons, white swelling, &c., are among the immediate or remote consequences of sprains of the ankle: they will be discussed in the appropriate general articles.

Art. IV. Diastasis of the Inferior Tibio-Fibular Articulation. This separation of the bones of the leg may be either partial or complete; the latter variety, however, is extremely rare. Partial diastases are never detected positively, as

they are always complicated with sprains and luxations with or without fracture of one or both bones of the leg, the symptoms of which mask these accidents. They require no modification of the treatment adapted to the accidents which produce them. Complete diastasis is mentioned by many surgical writers, as one of the possible consequences of sprains and luxations of the ankle: it is exceedingly rare, because the fibula breaks, in almost every case, before the ligaments of this articulation yield; and in falls from a height, the direct upward pressure of the pulley of the astragalus, combined with its lateral pressure on the external malleolus, and the consequent traction of the ligaments, sometimes force off a portion of the outer part of the lower extremity of the tibia, so as to leave the tibio-fibular articulation entire. M. Boyer narrates one very singular case, in which a luxation of the foot by adduction forced the whole fibula from both its articulations with the tibia, and drove it perpendicularly upward. By replacing the foot in its natural position, the fibula was, in this case, readily returned to its place. Diastasis of the lower articulation occurred once in the course of fifteen years, at the Hôtel Dieu, under Dupuytren. It was accompanied by consecutive fracture of the fibula, and what was termed by that surgeon, *dislocation of the foot outward and upward.* Two hundred cases of other fractures about the ankle, occurred during the same period. Sir A. Cooper does not notice any case of the kind. My attention was called, some years ago, to a case in the Pennsylvania Hospital, by Dr. Caspar Morris, of this city. The patient had received a very severe sprain of the ankle joint, attended with symptoms indicating a simple diastasis of the bones of the leg unattended by any fracture. There existed a slight tendency to abduction of the foot whenever the muscles were called into action, and the distance between the malleoli was then sensibly increased. When moved by the hand of the surgeon, the foot was found possessed of unusual freedom of motion, in lateral rotation of the toes and abduction, which motions greatly increased the separation of the malleoli, and permitted a slight sub-luxation of the foot. The cause most likely to produce this accident is, obviously, a violent abduction of the foot accompanied by a direct lateral pressure of the leg inward.

The *treatment* is very simple: a roller commencing at the toes, neatly applied about the heel and firmly surrounding the malleoli so as to keep them properly approximated, at once secures the patient against any lateral derangement of the foot. By placing the limb in the common fracture box (see *Leg, Fractures of*) and preserving the correct relation between the ball of the great toe and the patella, the tendency to evertion of the toe is also corrected. Such was the mechanical treatment in the case described, and it was completely successful. The firmness and correct position of the external condyle are so highly important to the exercise of the proper functions of the foot, that much time should be allowed for the recovery of the ligaments before the patient is permitted to use any violent exertion with the foot. Passive motions, avoiding those of abduction, should be employed pretty early in all severe injuries of this articulation, when not complicated with external wounds.

Art. V. Fractures about the Ankle. These are so various in their character and consequences, that it is difficult to classify them. They are caused either by direct forces, such as heavy blows, or the passage of great weights over this region, by violent extension of the natural motions of the foot, or the direct effect of the momentum of the body in falls. The fibula yields more frequently than the tibia, and the internal malleolus is sometimes torn off with or without the rupture of the fibula. As these cases are almost always complicated with primary or secondary sub-luxation of the foot, they will be noticed in the next article. The same may be said of that species of simple fracture which detaches the outer part of the inferior end of the tibia by the traction of the ligaments of the tibio-fibular articulation,—an accident always followed by fracture of the fibula also.

In falls attended by abduction, the astragalus is sometimes split, though this can scarcely occur except in compound dislocations. (See *Astragalus.*) There remain two other forms of fracture about the ankle, which require especial notice here.

§ 1. *Simple Fracture of both bones of the leg very near the ankle joint.* In this case, if the fracture is produced by a fall, the fibula is almost always broken higher up than the tibia, and in the latter bone the obliquity of the fissure is constantly from without, downward, and inward toward the malleolus internus. The reason of this is obvious from the fact that in such falls there is always a tendency to abduction of the lower fragment, both from the

arched form of the inner side of the tarsus, and from the mechanical advantages possessed by the abductor muscles, as already described in a preceding section.

The nature of the consequent displacement may be deduced from these data. The superior fragment descends more or less, and the limb is shortened in a corresponding degree. The mutual relations of all the parts concerned in the ankle joint are preserved; but the whole foot, together with the inferior fragments, being drawn or driven somewhat outward, an inward angular deformity is produced, which is generally greater as the seat of fracture is approximated to the joint. Both these species of displacement cause the lower and outer part of the superior fragment to ride over and conceal, more or less, the internal malleolus, and to become prominent on the inside of the joint beneath the integuments, so as to simulate a sub-luxation with abduction of the foot.

The *diagnosis* of this accident is by no means difficult. The depression on the outside of the leg, produced by the angular derangement of the fragments, instead of commencing at the external malleolus, as in the corresponding luxation, is located considerably higher, unless, as sometimes happens, the fibula is broken in more than one place. The shortening of the limb, when appreciable, is a clearly distinctive character; and any attempt to restore the foot to its proper position is productive of a deep-seated crepitus, between the tibial fragments.

The principal difficulty in the *treatment* of this species of fracture results from the constant tendency to a renewal of the displacement both in the longitudinal and lateral direction. It not unfrequently happens, however, that the fracture of the tibia has an obliquity so slight that the limb preserves its proper length after coaptation; and the case is then very simple, requiring nothing more than a common fracture-box for the limb (see *Leg, Fractures of*), with such an arrangement of the pillow, and, if necessary, compresses, as will effectually prevent lateral derangement and preserve the foot in its proper position. But when the inferior fragment is constantly drawn up by the muscles, it becomes necessary to check this tendency, either by the total relaxation of the great muscles, which may suffice in most cases, or by permanent extension and counter extension. All that is necessary to fulfil the first of these indications is to elevate the fracture-box, still preserving its horizontal position, so that the leg is flexed on the thigh and the thigh on the pelvis. Where permanent extension is required, the straight position of the whole limb, and Dr. Physick's modification of Dessault's splints, are almost universally employed in this country. (See *Thigh, Fractures of.*) The attempt to make counter-extension from the knee is inadmissible, as the bands used for that purpose embarrass the circulation. The extending bands should be so arranged as to act upon the heel and instep without covering the malleoli. Sir A. Cooper employs lateral carved splints with foot-pieces, in all fractures about the ankle; but the difficulty of adapting these exactly to each particular case is a strong objection to their use. (*Tr. on Fractures and Dislocations*, p. 332.) For all details on the general treatment and apparatus, the reader is referred to the articles on *Fractures*, and *Leg*.

§ 2. *Fractures of the Tibia communicating with the ankle joint.* These accidents result from considerable falls, and are various in character; sometimes the outer side of the lower extremity of the bone is driven off, continuing its connexion with the fibula; and if the fracturing force is expended in producing this mischief, the case resembles a diastasis of the tibio-fibular articulation, and requires the same treatment. It is distinguished from that accident by the crepitus produced by rotating the foot. If the force is continued, the tibia slides off from the articular pulley and descends internally, while the astragalus ascends between the bones of the leg, or rather between the fragments of the tibia, constituting what Sir A. Cooper terms *Dislocation of the foot upward.* (*Op. Cit.* p. 333.) If the articular surface of the tibia is comminuted in this accident, there may be a tendency to constant retraction of the foot, and more or less permanent deformity is generally the result. The obliquity of these fractures is often the reverse of that just mentioned. It passes from the joint upward and inward, producing a separation of the internal malleolus from the body of the bone. There is then a tendency to adduction of the foot, but its luxation is prevented by the integrity of the fibula and external lateral ligaments.

The *treatment* of these varieties of fracture should be regulated on the same principles, and requires the same apparatus, as the accident last described.

§ 3. *Fractures of the Fibula near the ankle joint.* In nearly every case of primary dislocation or sub-luxation of the an-

kle, the fibula becomes broken consentaneously, within a few inches of the joint. The causes, effects and treatment of these accidents, form the subject of the succeeding article, and we shall therefore confine ourselves in this place to the consideration of such fractures of the fibula as are occasioned by direct forces, and in which malpositions of the foot appear consecutively.

When any solution of continuity takes place in the fibula, between its two articulations, its fractured extremities are drawn towards the tibia by the fibres of several muscles which take their origin from the former bone. This angular deformity gives to both fragments an unnatural obliquity, which is of little consequence in the upper fragment, but is highly important in the lower; for the latter turns upon the inferior tibio-fibular articulation, as on a pivot; and as the superior extremity of this fragment tends toward the tibia, the malleolus externus is necessarily carried outward; the cavity which receives the head of the astragalus is thus widened, and the natural counter-check to the abduction of the foot is lost. If the fracture occurs within three inches of the ankle joint, the obliquity of the lower fragment is so great that a slight sub-luxation of the foot takes place merely from the contraction of the abductor muscles, and when reduced, the displacement continually reappears the moment that the foot is deprived of mechanical support. Even if the foot is maintained in its natural situation, the laxity of the peroneo-tarsal ligament permits the angular deformity to remain, and if the fragments are allowed to unite in this their malposition, the foot remains permanently subject to a degree of abduction incompatible with the proper exercise of its functions. The projection of the external malleolus beyond the end of the tibia is so short that it is extremely difficult to act upon it directly by means of any apparatus which will not at the same time press upon the portion of the fibula above the joint, and thus neutralize its own usefulness. The only sure mode of correcting the tendency to displacement is to act on the malleolus through the peroneo-tarsal ligaments, for when the foot is strongly adducted, these ligaments are put upon the stretch and compel the malleolus to return to its proper position, while the interosseous ligament of the leg prevents this motion from being carried so far as to produce an angular deformity in the opposite direction.

In order to maintain the foot in a state of adduction during the cure, the older surgeons employed a splint reaching from the knee to some distance below the foot on the outside of the leg, covered by cuneiform compresses with the base of the wedge downward, so as to extend quite to the sole of the foot; and a second splint on the inside of the leg, terminating at the inner ankle. The limb being enveloped in bandages as usual, and the splints applied, and secured by suitable means, the pressure of the thick extremity of the external compresses was designed to press the foot and the malleolus inward. The results of this treatment were avowedly unsatisfactory. (See Art. VI. § 1.)

It remained for M. Dupuytren to institute a more philosophical plan of treatment. The apparatus of this surgeon consists of, firstly, a cushion of linen about two-thirds filled with cotton, four or five inches broad, three or four thick, and long enough when doubled on itself to extend from the knee to the ankle; secondly, a firm splint from eighteen to twenty inches long, two and a half inches broad, and three or four lines thick; and lastly, two rollers, each four or five ells long.

The cushion when doubled upon itself lengthwise forms a kind of wedge. It is applied upon the inside of the leg, its thinner end corresponding with the condyle of the femur, and its thick doubled extremity extending to the internal malleolus, but not beyond it. Over this cushion the splint is secured with one end opposite the knee and the other extending five or six inches beyond the cushion, and two or three inches below the foot. The splint being fixed by one of the rollers passed round the leg and the apparatus near the knee, the other is carried by figure-of-eight turns round the projecting extremity of the splint and the foot, so as to embrace alternately the heel and the instep. The malleolus internus supported by the cushion is thus used as a fulcrum, and the foot being drawn and held in a state of adduction, over the end of the cushion, by the figure-of-eight bandage, the peroneo-tarsal ligaments are put on the stretch, and the malleolus is drawn inward without any counteracting force being applied to the upper part of the lower fragment of the tibia. (*Annuaire Médicale*, 1819.)

For many other particulars with regard to fractures of the fibula, complicated with displacements of the foot, and for our remarks on the applicability of the apparatus just described, in such cases, the reader is referred to the succeeding article on

Dislocations of the Ankle: we will therefore close the present section with the remark, that when the fracture occurs immediately above the lower tibio-fibular articulation, the inferior fragment is not displaced by muscular contraction, and hence it is not only unnecessary, but injurious to retain the foot in a state of strong adduction in such cases; for the traction of the peroneo-tarsal ligaments may then cause the fragment to follow the motions of the foot, as far as the elasticity of the peroneo-tibial ligaments permits, and thus a slight degree of deformity be produced, which may limit the proper freedom of abduction and circumduction after the union of the fracture is complete. This result we once witnessed. It is sufficient in such cases for the foot to be preserved in a perfectly relaxed position, which is easily effected by the same apparatus, care being taken to employ a cushion a good deal narrower at the summit of the wedge, than that above described.

Art. VI. Dislocations of the Ankle. The occurrence of a dislocation of the ankle free from complication with fracture is an exceedingly rare occurrence, if indeed it ever happens. The adduction of the foot would doubtless produce this accident frequently, were it not for the fact that the external lateral ligaments exceed in strength the fibula from which they arise; the tibia might indeed pass forward upon the dorsum of the tarsus, and if there should exist at the same time a diastasis of the tibio-fibular articulation, the fibula might escape fracture. The possibility of this accident has been noticed by several surgical writers, but we have met with no detailed case. It may be remarked with equal propriety that the dislocations of the ankle are never complete, except perhaps in one variety, for in no other case does the astragalus entirely quit the corresponding articular surfaces. The terminology of these accidents is in great confusion; by some surgeons they are described under the name of luxations of the astragalus (B. Bell. *Syst. of Surgery.* t. 7.), and are thus confused with other accidents of a very different nature. Many modern surgeons term them luxations of the foot; but they speak of luxations of the foot outward or inward, accordingly as the foot is abducted or adducted. (See S. Cooper. *Surg. Dict.* p. 402. Ed. 5.) Most of the French modern writers use the same terms, but in a sense precisely the reverse of that just mentioned. (See Boyer. *Mal. Chir.* t. IV., and Dupuytren. *Annuaire Médicale*, 1819.) They call a case of luxation with abduction of the foot a dislocation of the foot inward, and vice versâ, because the pulley of the astragalus is directed inward, when the foot is carried outward, and outward, when the foot is carried inward! In the attempt to prevent confusion from this diversity, Sir A. Cooper has increased the difficulty, by naming the different luxations of the foot according to the direction in which the lower extremity of the tibia is carried by the accident. (See his *Surgical Essays*, and *Treatise on Fractures and Dislocations.*) Thus he terms the dislocation with abduction of the foot, "*Dislocation of the tibia inward at the ankle joint*," and describes the others in a similar manner. I need hardly apologize then for the introduction of terms which it is hoped will prevent all misconception, particularly as the synonyms will be appended. The elucidation of the modus operandi of the motions of the foot in producing luxations, when carried beyond the proper extent, as given in a former article, render it unnecessary to dwell upon that subject here, and our remarks will be very short.

§ 1. *Sub-luxation of the ankle with abduction of the foot.* This is the *dislocation of the foot outwards*, of many surgeons; the *dislocation inwards*, of Boyer and Dupuytren; and the *dislocation of the tibia inward from the astragalus*, of Sir A. Cooper. The mechanism of its production, and the cause of its greater frequency, when compared with other injuries of the same class affecting this joint, have been explained in the first pages of this article. The relative changes among the parts of the articulation in this luxation are as follows. The deltoid ligament is torn, in part or entirely, from its connexions with the tibia, or, if this does not happen, the internal malleolus is fractured and detached by the traction of the ligament. The fibula is fractured above its articulation with the tibia, at some point within two and a half inches of that spot. The pulley of the astragalus inclines inward, and the lower extremity of the tibia slides off from its superior face, and descends more or less upon its inner side, so as to occasion a great prominence on the inside of the joint and a corresponding depression externally. The external malleolus retains its natural relations with the astragalus, following it in its displacement, so that the inferior fragment of the fibula inclines toward the tibia. That part of the

latter bone which gives attachment to the ligaments from the fibula is torn off from the shaft and follows the motions of the external malleolus. The superior fragment of the fibula, drawn inward by the interosseous ligament of the leg, follows the tibia and descends so as to approach the middle of the pulley of the astragalus, thus *taking the place of the bone just mentioned*, to use the language of Sir A. Cooper. The foot rests upon its inner edge, and the plantar surface is directed outward. If the foot has been suffered to remain in its false position until the muscles have contracted, considerable difficulty is experienced in any attempt at adduction; but abduction may be carried to such an extent as to cause the sole of the foot to present outward and upward. This complete overturning of the foot sometimes takes place in consequence of the continuance of the original fracturing force: it would occur more frequently but for the facility with which the other foot is made to arrest the descent of the body. In such cases the fibula is usually broken in more than one place, and the end of the tibia approaches the soil, commonly penetrating the integuments, so as to complicate the luxation with an external wound.

A dispute exists among surgeons as to the cause of the fracture of the fibula in this accident, which, as it has been made the foundation of certain practical injunctions, demands a passing notice. M. Pouteau asserted that it might be broken by the simple force of the muscles in making a false step. Most writers, among whom we may especially notice David and Boyer, consider the direct pressure on the malleolus, with the resistance of the tibio-fibular articulations, combined with the action of the peronei muscles, as the cause of the fracture, which they consider as the result of a kind of *contre-coup*. Dupuytren strongly opposes this doctrine, because on the dead subject he was able to produce luxation before the fracture took place, and he is therefore led to consider the latter as a consecutive accident; he moreover observes that in luxations by adduction, the fibula is broken by traction.

It appears obvious to us that the fracture may occur from either or any of these causes. That mentioned by Pouteau is perhaps the most questionable; but the whole mechanism of the joint goes to show the impossibility of a dislocation outward, from any of the forces that ordinarily produce it, without a contemporaneous fracture of the fibula, even supposing the deltoid ligament to have been previously torn from its connexions. We have already mentioned in the preceding article, that this disruption sometimes occurs without luxation, and the experiments of Dupuytren performed upon the dead subject, where the weight or the momentum of the body is not taken into account, furnish an argument to the contrary, of less force than might be at first supposed. The fibula is often primarily broken by direct force, and the foot consecutively luxated; a case at war with *the exclusive positions* of all the surgeons above mentioned. At last, this discussion derives its importance chiefly from the great names of the opponents. All that it is important to remember, in a practical point of view, is the fact that the fibula is always broken except in the unique case of its double diastasis (see Art. IV.), and that the peroneo-tarsal ligaments retain their connexions.

The indications for the *treatment* of this accident are, 1st, the speedy reduction of the foot to its natural position; 2d, the prevention of a recurrence of the displacement by muscular action; 3d, the correction of the tendency of the superior end of the inferior fragment of the fibula to approach the tibia, which if unchecked would cause the external malleolus to turn obliquely outward so as to render the astragalus unsteady in its socket; 4th, the arrest of the inflammatory symptoms; and 5th, the prevention of consequent stiffness in the joint.

The first indication is easily fulfilled if the accident is of recent occurrence, but if several days have been suffered to elapse much difficulty may be experienced. To effect the reduction in the easiest manner, the surgeon flexes the thigh on the pelvis, and the leg on the thigh; he then directs one assistant to interlock his hands behind the limb just above the ham, and another to grasp the front of the leg just above the site of the fracture in the fibula. He then seizes with one hand the projection of the heel, and with the other, the inner edge of the foot, the fingers passing over the instep, and the thumb resting beneath the sole. He then directs the toes a little downward, in order to relax the muscles as much as possible, and making steady extension, at first a little outward and then more directly downward, he causes the foot to reverse the motion which occasioned the luxation. We have never seen a case in which the muscular contractions resisted these simple efforts at reduction, before the reunion of the fibula had rendered all such attempts improper; but as such instances are said sometimes

to occur, it may be remarked that the silk handkerchief, applied as directed for extension in fractures of the lower extremities complicated with injury about the malleolus, will furnish the best means of increasing the extending force. (See *Leg, Fractures of.*) With regard to the second indication it should be observed that the articular surface of the tibia effectually opposes all displacement so long as the foot is kept in its natural position by mechanical means; but these measures are insufficient for the fulfilment of the third indication; for the displacement of the inferior tibial fragment does not depend solely on the malposition of the foot, but also upon the action of the peronei muscles. This constitutes the chief difficulty in the treatment of nearly all the dislocations of the foot; and it is to Dupuytren that we owe the first correct description of the most rational means for combating the evil. Mr. Pott, led astray by his favourite theory of relaxation in fractures, and attributing the lateral displacement of the external malleolus mainly to the pressure of the astragalus upon it, under the action of the abductor muscles, contented himself with placing the patient on the injured side, with the thigh and leg in demi-flexion, and the outside of the foot resting on the bed. Mr. Bromfield, who displays a better knowledge of the indications in these accidents, attempted to act directly upon the malleolus by means of graduated and stiffened compresses and a figure-of-eight bandage. (*Surg. Obs. and Cases.* II. 77.) Most English surgeons have followed up the ideas of these authorities. The application of graduated compresses and the flexed position are retained, and the limb continues to be enveloped in a many-tailed or Scultet's bandage; but lateral splints are added to the apparatus to render its action more steady. Sir A. Cooper (*Loc. Cit.*) uses his splints with carved foot-pieces. The French prefer the extended position, but all those who preceded Dupuytren seem to have acted in other respects upon the same principle. Boyer employed two plain splints, one for the outside of the leg, extending from the knee to some distance below the foot; the other, internal and terminating at the inner malleolus. These, lined by chaff-bags, were applied over the graduated compresses and roller, the long splint pressing the foot inward. (*Mal. Chir.* IV. 384 and 386.) There can be no important advantage gained by the flexed position in these accidents, for the slightest examination of the joint will show that the reduction once accomplished and the foot secured against abduction, the extension of the muscles of the leg tends rather to secure the astragalus in its proper position than to cause displacement; but there are very strong objections against the modes of dressing above described. Graduated compresses secured by roller or the many-tailed bandage produce considerable pressure on the whole length of the fibula. Now the slight projection of the malleolus causes the pressure on this part to act at a very slight mechanical advantage, while the length of the lower fragment of the fibula is usually so considerable that pressure upon its upper end acts with at least three-fold force, as may be proved by actual admeasurement and the application of the law of the lever. Dupuytren employs the external lateral ligaments themselves to counteract the muscles, in the manner described in the section on fractures of the fibula. (Art. V. § 3.) By the employment of his apparatus, the lateral ligaments draw inward the external malleolus with any required degree of power, and no pressure need be applied to the upper end of the fibular fragment. (*Annuaire Médicale.* 1819.) Care should be taken not to carry the adduction too far, or the astragalus will display a tendency to overturn in the opposite direction, in which case, if the internal malleolus is broken, it will be displaced, and if it retains its integrity, it compels the outer edge of the pulley to react on the external malleolus so as to lessen the effect of the traction of the ligaments by shortening the arm of the lever on which they act.

This mode of treatment is equally applicable to many of the other luxations of the foot, as they are almost invariably complicated with fracture of the fibula, which at once becomes one of the most important features in the case.

The fourth and fifth indications need not be dwelt upon in this place, as they are common to these and all other fractures complicated with sprains and luxations, and will be considered under the appropriate general heads.

§ 2. *Sub-luxation of the ankle, with adduction of the foot.* This is the *dislocation of the foot outwards*, of Dupuytren and Boyer; *dislocation inward*, of most surgeons; and the *dislocation of the tibia outward from the astragalus*, of Sir A. Cooper.

This accident is much less frequent, but proportionably more formidable, than that described above. The foot moves in the opposite direction; the external mal-

leolus is torn off by the lateral ligaments; the internal, is either detached by the pressure of the astragalus, or the inner side of the extremity of the tibia is fractured obliquely in a direction from the joint upward and inward; the remainder of this bone starts outward and forward before the external malleolus; and the fibula generally yields in several places. Even the astragalus may be split, through the pulley; this articular process is overturned, so that its superior face presents obliquely outwards; the broken end of the tibia descends on its outer side; the external malleolus becomes very prominent at the corresponding side of the joint, and is exceedingly apt to penetrate the integuments; the inner side of the pulley pushes upward the inner fragment of the tibia; the corresponding edge of the foot inclines upward, the other edge rests on the ground, and the plantar surface looks obliquely inward.

The indications in this, are nearly the same with those in the former lateral luxation; but we have also to guard against the tendency of the foot to be carried inward. The reduction is accomplished in the same manner as in luxation by abduction, the foot being carried in a nearly contrary direction; but if great difficulty is experienced, the operator can use an extending band which may be given to a third assistant, and by pressing with one hand on the heel and the other on the lower end of the tibia, he may then employ any warrantable degree of force.

Surgeons have generally treated this accident with the same apparatus that they have severally employed in the subluxation with abduction, reversing the order of the compresses so as to make the greatest pressure upon, and below, the internal malleolus, and to thrust the foot outward; but it must be borne in mind that all the evils resulting from an ill-managed fracture of the fibula must necessarily follow this process, for the external malleolus is driven outward by such a plan of proceeding, and there is as little security against displacement of the foot in that direction as in the other.

Dupuytren employs the apparatus devised by himself for fractures of the fibula, placing the cushion in these cases on the outside of the leg, and keeping the foot in a state of permanent abduction over its doubled extremity. The objection just stated applies with still greater force against this mode of treatment.

The foot is rendered exceedingly unsteady by this double fracture of both bones of the leg, and in some cases the slightest change in its position enables the muscles to renew the displacement. Fortunately, the fibula, when it yields to traction, is generally ruptured immediately above the articulation with the tibia: the lower fragment is not then drawn inward by muscular contraction, and no degree of derangement among the other fragments of this bone can materially injure the motions of this joint so long as the malleolus retains its proper relations.

The great object then is to keep the foot in a perfectly relaxed position, i. e. to retain the point of the great toe nearly on a line with the patella, with the toes pointed somewhat downward, and the tarsus in a state of semi-adduction on the astragalus. This is easily accomplished by adjusting the limb in a common fracture-box, or by applying two lateral splints from the knee to the ankle, with well arranged chaff-bags, and bands passed round the toes and secured to the splints if necessary.

The carved splints of Sir A. Cooper are objectionable because they cannot be adjusted to particular cases without great difficulty, are not easily procured, and often interfere unnecessarily with local applications to the ankle.

This accident is always attended with sprain of the articulations between the astragalus and tarsus, which circumstance should not be overlooked in the treatment.

§ 3. *Luxation of the foot backwards.* This dislocation may be either partial or complete. It is caused by violent extensions of the foot, in falls and other accidents, when the foot is suddenly arrested while the momentum of the body continues. It may be caused by the heel catching on the edge of a step when descending a flight of stairs (see Dorsey's *Elements of Surgery*); but perhaps the most frequent cause is a fall from a height, on an inclined plane, when some accidental irregularity of surface prevents the subluxation from abduction. The accident is rare. M. Boyer declared, in 1814, that but one case had ever fallen under his observation.

In the partial luxation, Sir A. Cooper remarks that the tibia rests half on the astragalus and half on the os naviculare; the fibula is broken; the heel is shortened; and the distance from the malleoli to the toes is proportionally increased. The latter are pointed downward in consequence of the contraction of the great extensor muscles, and the ankle joint is rendered nearly immovable with the toes

only resting on the soil. It is distinguished from complete luxation by the slighter extent of the deformity, and the accident may be masked by the swelling which soon supervenes.

In the complete luxation, the tibia rests almost entirely on the os scaphoides and the internal os cuneiform, its posterior edge merely touching the front part of the pulley of the astragalus. The toes point strongly downward, resting on the ground. The joint is immovable, and the front part of the foot is so much shortened that the accident cannot be mistaken. The fibula is broken, and its upper fragment passes forward with the tibia. The tibio-fibular ligaments do not yield, and the external malleolus remains *in situ*.

Reduction is accomplished by placing all the muscles interested, in the greatest possible degree of relaxation, and effecting extension, either by the hands of the surgeon, or by means of a handkerchief applied in the manner to which we have already alluded when speaking of the lateral sub-luxations, the foot being carried forward at the same time, and gradually flexed, as the pulley returns to its place. To aid in effecting the extension it is proper for one assistant to support the thigh near the ham with his clasped hands, while a second embraces in the same manner the front of the leg about four inches above the ankle. In this accident the deltoid ligament is detached more or less completely, the transverse posterior ligament of the tibio-fibular articulation is injured, the anterior ligament of the ankle is lacerated, and the front part of the synovial membrane torn.

When reduced, the fracture of the fibula leaves the joint liable to the consecutive sub-luxation by abduction (q. v.), and the case demands the treatment adapted to that species of injury; but as the transverse posterior ligament is weakened, it is necessary to be more particular in keeping the foot well flexed upon the leg, in order that the great extensor muscles may act at right angles to the antero-posterior axis of the joint, else they would tend to draw the foot backward and might reproduce the luxation.

§ 4. *Luxation of the foot forwards.* This is enumerated among the possible accidents of the ankle joint, and some writers go so far as to explain the mechanism of its production (see Boyer. *Mal. Ch.* t. IV.), but its existence is problematical. Should it occur, the inferior extremity of the tibia would be found resting on the back of the os calcis with the front edge overlapping the posterior margin of the astragalus, the projection of the heel being almost destroyed, and the front of the foot proportionally elongated. The method of reduction would consist in making as much extension as possible, both by directly drawing the foot downward, and by depressing the toes, so as to use the whole foot like a lever while it is forcibly thrust backward. When reduced, this case would resemble the last, in all essential particulars.

In all cases of luxation of the ankle, it is highly important to guard against the stiffness of the joint consequent upon the extensive alterations and adhesions of the ligaments and tendinous thecæ, while every precaution should be used to prevent undue exertion until the tardy process of reunion in the white tissues is fully established. As a general rule, passive exercise may be commenced in four or five weeks, according to the age of the patient, it being held constantly in mind that the natural motions of this articulation are simply those of flexion and extension—all others are injurious. In six or eight weeks the patient may leave his bed, but he should be prohibited from using great exertions for several months. The complete union of the fractured bones is no sufficient proof of the firmness of the ligaments.

§ 5. *Compound luxations of the ankle.* These were formerly considered as cases always requiring amputation, but in latter times so many grave accidents of this kind have recovered without even the entire loss of the movements of the joint, that it has become customary to attempt the preservation of the limb under very desperate circumstances. We have seen so many patients succumb under these attempts, that we have been inclined to think the profession in danger of passing from one extreme to the other. The question of the propriety of amputation is often one of great difficulty. In patients of vigorous constitution, surrounded with all the conveniences of life, and provided with the best surgical advice and suitable assistance, the knife is very rarely required. Even in such cases, however, the division of both the tibial arteries, the very extensive laceration of the soft parts, or the comminution of a great extent of bone, is considered a sufficient reason for removing the injured parts. On the contrary, when such luxations occur on the field of battle, in places where the supervision of experienced surgeons cannot be had, or where the poverty of the patient deprives him of

the necessary resources, amputation should be occasionally performed in cases that would in all probability recover under more favourable auspices. Whenever any of the bones protrude in a dislocation of the ankle happening to a very weakly patient, one who has recently recovered from severe and debilitating disease, or in whom symptoms of pulmonary consumption have made their appearance, the chances are very much against the recovery. Sir A. Cooper expresses his surprise at the extreme infrequence of injury to the posterior tibial artery, the anterior tibial being the only vessel that he has seen injured (*Tr. on Fractures and Dislocations.* p. 242.); the arrest of the circulation in the foot must therefore be a very rare occurrence.

We shall not enter into the history of the constitutional symptoms which follow these accidents, nor the treatment which they require. These details, and the questions of the propriety of removing isolated fragments, and of excising the projecting extremities of the bones when irreducible, &c., are more properly referred to the general article on *Dislocations* (q. v.), and it is only necessary at present to notice a few points peculiar to luxations of the ankle.

Nearly all the cases of compound dislocations of this joint are the result of the lateral displacement of the foot. When the accident is occasioned by abduction, it is generally the tibia only that penetrates the integuments, but when the foot is dislocated by adduction, both bones appear, the superior fragment of the fibula descending with the tibia, and penetrating the integuments first. In each variety, the projecting bones are very apt to reach or even to enter the ground, and become covered with dirt and other foreign substances; these impurities must be removed with the utmost care before the bones are replaced, or very terrible consequences to the joint may follow. The reduction is accomplished in the manner prescribed for similar luxations when simple, the wound being enlarged if necessary to free the protruded bones from stricture. Sir A. Cooper directs as the first dressing to the wound, a piece of lint dipped in the blood of the patient, which he considers as the blandest and most congenial application that can be made.

In some happy instances the wound adheres without inflammation of the joint, and the case is converted into a simple luxation; but if this process fails, suppuration of the cavity, often followed by exfoliation of the bones, and anchylosis, is the result. Still, as the eminent surgeon just quoted remarks, the motion of the joint is not always lost. If passive motions are practised as early as possible, it is not unfrequently preserved in a great degree, and even in worse cases, the gradual extension of the natural motions of the tarsal articulations in part supplies the defect, with time. The time required for the recovery, after suppuration of the joint, is always very considerable: "Under the most favourable circumstances, three months generally elapse before the patient can walk with crutches; in many cases, however, a greater length of time is required." (*Op. Cit.* p. 245.)

It is impossible to lay down any positive and general rules for the mechanical treatment of these accidents; but one point must be kept steadily in view; the foot must be carefully preserved at a right angle with the leg, in order that if the motion of the joint is lost it may be permanently fixed in the most favourable position. In some cases the limb may be best supported in a fracture-box, in others it may require one, or even two lateral splints with graduated compresses; sometimes it is best placed on the side, and at others on the heel. The general principles laid down in speaking of the simple luxations should guide us whenever the character of the case does not require some peculiar contrivance. For further details, see Art. *Dislocation.*

Other accidents to the ankle, in which the astragalus is more particularly interested, will be described in a separate article. (See *Astragalus.*)

§ 6. *Dislocation of the foot outward and upward.* A term applied to a complicated species of diastasis of the inferior tibio-fibular articulation. (See Art. 4.)

§ 7. *Dislocation of the foot upward.* A term applied by Sir A. Cooper to a complicated fracture of. the tibia communicating with the ankle joint. (See Art. 5. § 2.)

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REYNELL COATES.

ANODYNES. (From α priv. and οδυνη, pain.) This name, as its origin indicates, is applied to medicines calculated to relieve pain. To one who considers how numerous are the causes of pain, and how various are the morbid conditions with which it is associated, it must be obvious, that the possession of a power to mitigate or remove it cannot properly serve as the basis of a class in the Materia Medica; for, otherwise, substances would be thrown together wholly different in their nature and modes of action; and, in fact, the whole catalogue of medicines would be compressed into a single class; as there is scarcely one which, under certain circumstances, may not be made, either directly or indirectly, to produce an anodyne effect. It would be futile, therefore, to attempt to give, under this head, a full account of the properties of anodynes, their modes of operating on the system, the indications for their use, and the rules which should regulate their administration. This information must be sought for in the observations upon the various recognized classes of medicines, and upon the medicines themselves individually considered. A few brief remarks, however, may be useful by serving to give precision to the subject.

Pain may be relieved in one of three ways; *first,* by removing the exciting cause of that irregular action of the nerves on which it depends; *secondly,* by correcting this irregular action through the agency of means directly addressed to the nervous system; and *thirdly,* by diminishing sensibility through narcotic impressions on the brain. Anodyne remedies may be arranged in divisions corresponding with these several modes of action.

1. The first division includes, *first,* all such means as are calculated to remove or neutralize extraneous sources of irritation, as emetics and cathartics in colic from undigested food or acrid secretions, anthelmintics in verminose complaints, and antacids in cases attended with an unhealthy accumulation of acid; and *secondly,* all such as relieve inflammation, comprehending demulcents, emollients, refrigerants, and the whole list of evacuants.

2. In the second division are embraced those medicines which, by some unexplained influence upon the nervous system, correct its painful irregularities, without impairing its healthy powers; such as carbonate of iron and sulphate of quinia in neuralgia, and ammonia and other incitants without narcotic properties, in the purely spasmodic affections.

3. The third division is that to which the term *anodyne* is most usually applied, and to which it ought, perhaps, to be restricted. It consists of those medicines which, by a direct influence on the brain, diminish its capacity for receiving impressions, and consequently render it more or less insensible to those of a painful nature. These are the only medicines which relieve pain under all circumstances and from whatever causes, and therefore pre-eminently merit the name. They might, at first sight, appear to claim consideration as a distinct class; but they all belong to the *narcotics,* and, as their property of relieving pain is merely incident to the more general power over the cerebral functions by which this class is characterized, they will be more conveniently treated of under the same head. It may here be observed, that they are highly useful in a wide circle of diseases, not only by contributing to the comfort of the patient, but also by relieving the system from the excessive and often exhausting irritation of pain and consequent wakefulness, which often aggravate existing diseases, and render an otherwise mild case alarming if not dangerous. In their employment, however, reference should always be had to their narcotic and frequently stimulant properties, and the possible aggravation which these properties may occasion in inflammatory affections, especially of the brain or its membranes. Care should, moreover, be taken, when they are used in inflammations, that the relief which they afford to the pain, should not be mistaken for a subsidence of the disease itself. Otherwise, the organic affection, which is not necessarily moderated by the remedy, may go on increasing unobserved, and may be undermining

the citadel of life, while its advances are masked by the defences erected to ward off its open assaults.

Comparatively few of the narcotics are habitually used as anodynes. Of these, *opium* is incomparably the most effectual. *Hyoscyamus* and *lactucarium* are occasionally substituted, when this remedy acts unfavourably from peculiarities in the constitution of the patient, or the nature of the disease. *Camphor* is also frequently used in reference to its anodyne properties. *Conium*, *belladonna*, and *stramonium*, have, to a certain extent, the same effect; but they are generally prescribed rather with a view to their supposed agency in subverting the existing morbid action, than merely for the relief of pain.

Geo. B. Wood.

ANOMALOUS (From α priv. and ομαλος, regular.) Irregular, contrary to rule. A disease is called anomalous which cannot be referred to any known species; or in whose symptoms and progress there is something unusual. I. H.

ANOMOCEPHALUS. (From α priv., νομος, rule, and κεφαλη, head.) Geoffroy St. Hilaire has bestowed this epithet upon one of his genera of monsters, which comprises all those individuals whose heads are deformed. (See *Anencephalus*, *Monsters*, &c.) I. H.

ANOMPHALOS. (From α priv. and ομφαλος, umbilicus.) Without a navel. I. H.

ANORCHIS, or ANORCHIDES. (From α priv. and ορχις, testicle.) Without testicles. I. H.

ANOREXIA, or ANOREXY. (From α priv. and ορεξις, appetite.) Want of appetite, inappetence, absence of desire for food without loathing. It may exist in various degrees, from simple diminution of appetite to complete inappetence. The seat of appetite appears to be the mucous membrane of the stomach; and inappetence is a frequent result of all the pathological conditions of that tissue. In some of the most serious disorganizations of the stomach, as softening, ulceration, and induration, it is often the only symptom which indicates these diseases. Its utility, however, as a diagnostic sign, is lessened by the fact of its sometimes existing for a long period without the stomach presenting after death any appreciable lesion, and, on the other hand, lesions of this viscus are sometimes unattended with any diminution of appetite. Anorexia occurs not only in the primary diseases of the stomach, but also when this viscus becomes secondarily affected; it is thus frequently present in almost all the acute phlegmasia and in many chronic affections, and indicates that the stomach sympathizes in the sufferings of the other organs. It must be manifest from this view of the subject, that anorexia is not properly a disease as it was considered by the nosologists, but a symptom; the expression of some pathological condition of the gastric mucous membrane. The *treatment* of anorexia must of course be directed to the cure of the disease of which it is the symptom. In most cases, anorexia indicates the inaptitude of the stomach to receive food, and it must then be considered as a useful signal exhibited by nature for the necessity of abstinence. Nothing can be more injurious in such cases than the too frequent practice of attempting to excite the appetite, by stomachics as they are termed, most of which are strong stimulants, as the bitters and bitter and aromatic tinctures, which infallibly excite or aggravate the irritation of the stomach, and lead to serious and often to fatal disorganizations of this viscus. (See *Gastritis*.) Sometimes, though rarely, anorexia results from a state of asthenia or atony of the stomach, as in convalescence from certain diseases; occasionally from prolonged or rigid abstinence; and where the irritability or excitability of the stomach has been exhausted by the habitual use of stimulating food or drinks. In such cases, the bitter tonics may be useful. They should be conjoined with nutritious food, exercise in the open air, and carbonated chalybeate waters. (See *Convalescence*, &c.) When anorexia is caused by excessive indulgence in opium, tobacco, or similar articles, their use must be abandoned. If the loss of appetite is the consequence of literary labour, too sedentary habits, grief, or violent passions; the cessation of study, amusements, riding or other exercise, change of residence, &c., are to be recommended. In short, the disease, of which anorexia is the symptom, must be sought for, and the remedies be directed to its cure. (See *Appetite, pathological conditions of*, *Dyspepsia*, &c.

I. Hays.

ANORMAL, or, more properly, ABNORMAL. (From *ab*, without, and *norma*, rule.) Irregular, not conformable to rule. I. H.

ANOSMIA. (From α priv. and οσμη, odour.) Diminution or loss of the sense of smell. The seat of this sense is the mucous membrane, lining the superior portion of the nasal fossa; but an essential part of the mechanism of all sensations is their

transmission to the brain, and their perception by or repetition in this organ. Anosmia may result from a pathological condition, either primary or secondary, of any portion of this apparatus: it is a symptom of such lesion. It occurs in coryza; in irritations productive of suppression of the secretion of this tissue; in ulcerations of this same membrane, &c. It also occurs in various lesions of the olfactory, of the fifth pair of nerves, and of the portion of the brain appropriated to the perception of odours. It is sometimes congenital, from a vice of conformation; remarkable instances of which have been related by DESCHAMPS and BRESCHET.

The *treatment* of anosmia must of course be directed to the removal of the diseases of which it is but the symptom, and will be pointed out in the proper articles. (See *Smell, pathological states of*, &c.) I. HAYS.

ANTACIDS, or ANTI-ACIDS. (From αντι, against, and *acidus*, acid.) Substances which possess the property of correcting acidity, especially in the stomach. They all act chemically, by uniting with the acids, thus neutralizing them; such are the alkalies, magnesia, &c. (See *Dyspepsia, Cardialgia*, &c.) I. H.

ANTAGONISM. (From αντι, against, and αγωνιζειν, to act.) The resistance which two opposite forces offer to each other. I. H.

ANTAGONIST. This term is employed in anatomy to designate certain muscles whose action is in an opposite direction to that of others. Thus the extensors and the flexors are reciprocally antagonists; so also the abductors and adductors, the pronators and supinators, &c. As there is no motion in one direction without a capability of it in another, every muscle has its antagonist. Without this arrangement all movement would be impossible, as is shown by the phenomena of paralysis. Thus, in hemiplegia, the muscles of one side having lost their contractility, those of the opposite side are no longer counterbalanced in their action, and they draw the parts to which they are inserted, out of their situation; and hence the distortion of the mouth. I. H.

ANTAPHRODISIAC, and ANTIPHRODITIC. (From αντι, against, and αφροδιτη, venus.) Remedies which diminish or abolish the venereal appetite. By the ancients, several articles, as the *Agnus castus*, *Nymphæa alba*, and Camphor, were supposed to be endowed with this special property; but the moderns have denied the possession, by any medicine, of such powers. The term antaphrodisiac has consequently fallen into nearly entire disuse, or there are arranged under this head, only those general debilitants and hygienic measures which act upon the whole system, and thus diminish the sensibility or orgasm of the sexual organs. Some facts which have been recently communicated to us, seem however to show that we really possess a remedy, viz., the Dulcamara, which enjoys antiphroditic powers. We are indebted for a knowledge of this, to our venerable and respected friend Dr. DEWEES. This careful and accurate observer informs us that he was led to the discovery of the property just noticed, in the dulcamara, from the circumstance of a gentleman who was taking, by his direction, a decoction of the plant (1 oz. to a pint of water, the whole in divided doses during the day) for the cure of an herpetic affection, complaining that his venereal appetite had ceased. The medicine was discontinued, and the patient was restored to his usual state. To ascertain whether or not the loss of venereal appetite was really the effect of the action of the dulcamara, Dr. D. requested his patient to resume the use of the medicine, and the same result followed; it was again discontinued, and the effect ceased. Dr. D. has since seen the same phenomenon follow the use of this medicine under similar circumstances. This has led him to prescribe it in two cases of nymphomania and one of satyriasis, and with the most successful results. Our friend Dr. THOMAS HARRIS, to whom these facts had been communicated, informs us that he has administered the article in five cases, and in every one its use was followed by an extinction of the venereal appetite; which, however, returned after the medicine was discontinued.

The further discussion of this subject here, would involve repetition; we will therefore refer the reader to the articles, *Dulcamara*, *Nymphomania*, *Onanism*, *Priapism*, and *Satyriasis*, where it will be considered in all its details.

I. HAYS.

ANTIVERSION OF THE UTERUS. (See *Uterus, Displacements of.*)

ANTHELMINTICS. (From αντι, against, and ελμινς, a worm.) Under this title, in its most extensive signification, are included all medicines calculated to free the alimentary canal from the worms with which it may be infested, or to prevent their generation in cases in which a predisposition to them may exist. But, considered as the name of a distinct divi-

sion in a systematic arrangement of the Materia Medica, the term has a more limited application. The class of anthelmintics, strictly speaking, embraces those medicines only which prove noxious or poisonous to the worms by a direct action upon them; not such as operate against these parasites by their influence on the functions of the stomach and bowels, in other words, by means of properties which are incident to them as members of other classes. Emetics and cathartics, therefore, though frequently very efficacious in the expulsion of worms, and tonics, though useful in preventing their subsequent development, cannot properly be considered as belonging to the class of anthelmintics; as their influence depends on those very qualities which entitle them to the rank of emetics, cathartics, and tonics. An account of these latter remedies, in their relation to verminose complaints, belongs to a pathological and therapeutical treatise on worms, and to this head the reader is referred. In the present place we shall speak of anthelmintics only in the limited acceptation above explained.

These medicines relieve the alimentary canal from the presence of worms, either by occasioning their death, and thus exposing them, like other lifeless matter, to the expulsive or digestive powers of the stomach and bowels; or by so far debilitating them as to disable them from resisting the peristaltic motion, especially when increased by purgatives; or finally by rendering their situation in the body uncomfortable, and thus disposing them to escape with the feculent matter, or, as sometimes happens, along with the contents of the stomach in vomiting.

Their operation upon the worms may be either poisonous or mechanical. There is no doubt that some medicines prove fatal or noxious to these animals without affecting the human system injuriously. Thus, worms are sometimes discharged dead, after the administration of an anthelmintic which produces no unpleasant effect upon the patient; and, if introduced into an infusion of certain vermifuge medicines out of the body, they die much more speedily than when immersed in pure water. There is reason to believe that worms in the upper bowels and stomach are sometimes partially or completely digested, after having been destroyed by the medicine administered; as fragments of the animal are occasionally found in the discharges from the bowels, and symptoms of stomachic worms, of the most unequivocal character, have disappeared under the use of the oil of turpentine, without any appearance of worms in the evacuations.

There seems to be no good reason for the scepticism which has been entertained by some in relation to the mechanical operation of certain anthelmintics. It may be true that a substance capable of injuring or destroying worms in this way, may also irritate to a certain extent the alimentary canal; but leaving out of the question the protection afforded to the lining membrane of the stomach and bowels by the mucus which covers it, we may readily account for the comparative impunity of the patient, by reflecting upon the circumstances of position which more completely subject the worm to the action of the irritant, and upon the relative extent of surface exposed, which, in the one instance, is the whole body of the animal, in the other, only a small portion, at any one time, of the alimentary mucous membrane An experiment made by Mr. CHAMBERLAINE satisfactorily proves that cowhage at least operates mechanically as a vermifuge. Among some round worms contained in a calabash, he sprinkled the sharp hairs of the pod of the Dolichos pruriens. At first no visible effect was produced; but very soon the worms began to writhe about and evince signs of extreme pain; and, on examination by the microscope, it was found that the hairs had in several instances penetrated deeply into the body.

It has been conjectured that the fixed oils, such as olive-oil and castor-oil, which have sometimes been given as anthelmintics, prove fatal to the worms by preventing the access of air, which is as necessary to their existence as to that of other animals.

The number of substances really or conjecturally possessed of anthelmintic properties, and which have, at various times, and in different parts of the world, been employed in verminose complaints, is very great. Among those which may be considered most efficacious, and in different times and places have enjoyed the highest popularity, the following may be enumerated:—Azederach (bark of the root of the *Melia azederach*), Bear's foot (*Helleborus fetidus*), Cabbage-tree bark (*Geoffroya inermis*, or *Andira inermis*), Camphor, Cowhage (setæ of the pods of the *Dolichos pruriens*), Male fern (root of the *Aspidium Filix Mas*), Mercury, Oil of turpentine, Pink root (*Spigelia Marilandica*), Pomegranate root, Rue, Savine, Tin in powder or filings, Tobacco, Wormseed of the Levant and Barbary (dried unex-

panded flowers, &c. of different species of *Artemisia*), and Wormseed of this country (*Chenopodium anthelminticum*). Bitters, which undoubtedly serve, in some instances, by their tonic property, to put the stomach and bowels in a condition unfavourable to the production and sustenance of worms, are thought by some to be directly noxious to the animals, and therefore properly anthelmintic. The alkalies and alkaline earths, which have also been found useful in verminose complaints, probably act merely by their antacid property. There is reason to believe that some of the purgatives are anthelmintic, independently of their cathartic powers, particularly aloes and calomel, the former of which probably acts immediately on the worm, the latter through the agency of the very acrid bile which it often occasions the liver to secrete.

GEO. B. WOOD.

ANTHEMIS. (*Botany.*)

Sex. Syst. Syngenesia Superflua.—*Nat. Ord.* Compositæ Corymbiferæ.

Gen. Ch. Receptacle chaffy. *Sceddown* none, or a membranaceous margin. *Calyx* hemispherical, nearly equal. *Florets of the ray* more than five. WILLDENOW.

1. *A. Cotula.—May-weed, Wild chamomile.—Camomille puante, Maroute*, Fr.; *Hunds-Kamille, stinkende Kamille*, Germ. —*Sp. Ch.* "Receptacle conical; chaff setaceous; seeds naked; leaves bipinnate; leaflets subulate, three-parted." WILLDENOW. This is an annual plant, with an erect, striated, branching stem, from one to two feet high, bearing alternate, sessile, doubly or triply pinnate leaves, with linear, pointed, and smooth or somewhat hairy leaflets. The flowers are compound, with a yellow disk and white ray, and stand singly on the summit of the branches. The calyx is hemispherical, and consists of linear imbricated scales. All parts of the plant have a disagreeable fetid odour, and a warm bitter taste. It is a native of Europe, and grows wild in abundance in the United States, though supposed to have been introduced. It is found along the roads, among rubbish, and in waste places about towns and villages. Its flowers appear in July, and continue till late in the autumn.

The may-weed yields its properties of smell and taste, together with its medical virtues, to water. Its effects upon the system are those of a mild tonic; and it may be used for the same purposes as officinal chamomile, though much more disagreeable. Its fetid odour has led to the impression that it possesses antispasmodic powers; and hence it has been given in hysteria and other nervous complaints. It has also been employed as an emmenagogue; but probably acts, like most other herbs given in the state of hot infusion, in amenorrhœa, only by the warmth of the vehicle united with the slightly excitant property of its volatile oil. In this country, the plant is scarcely employed in regular practice. The whole herb is active; but the flowers are preferred for internal use, on account of their less disagreeable flavour. The form of administration usually preferred is that of infusion. On the continent of Europe, a strong infusion is used as an enema in nervous complaints.

2. *A. nobilis.—Chamomile, Roman chamomile.* — *Camomille, Camomille Romaine*, Fr.; *römische Kamille, edle Kamille*, Germ.—*Sp. Ch.* "Leaves bipinnate; leaflets three-parted, linear-subulate, somewhat villose; stem branching at the base." WILLDENOW. Chamomile is a perennial herbaceous plant, with several stems, from six inches to a foot long, horizontal at the base, erect at the extremities, more or less branched, smooth below, and downy above. The leaves are alternate, bipinnate, and covered with a very fine pubescence, which gives them a grayish-green colour. The leaflets are small, slender, pointed, and divided into two or three lobes. The flowers are solitary and terminal, with a yellow convex disk and white ray. The calyx is hemispherical, and composed of several small, imbricated, hairy scales. The florets of the ray are numerous, narrow, and terminated by three small teeth.

The plant is a native of Europe, where it is abundantly cultivated for medical use. It has been introduced into this country, and may be observed in some places growing wild. In our gardens it is cultivated as a domestic medicine, the whole herb being employed in the form of infusion. It flowers in June and July. All parts of the herb have a peculiar fragrant odour, and a bitter aromatic taste, and all possess medical virtues; but the flowers only are officinal. (See *Chamomile.*)

3. *A. Pyrethrum.—Pellitory of Spain.* —*Pyrèthre*, Fr.; *Bertram-Kamille*, Germ. —*Sp. Ch.* "Stems simple, one-flowered, decumbent; leaves pinnate, many-cleft." WILLD. *Sp. Plant.* The root of this plant is perennial, long, tapering, furnished with small fibres, and of a whitish colour externally. It sends up several herbaceous stems, which are usually simple, round, trailing at the base, erect at the extremity, scarcely a foot high, and terminated by a solitary flower. The leaves are doubly

pinnate, with narrow linear segments of a pale green colour. The flowers are large and beautiful, with a yellow disk, and rays which are white on the upper surface, and purple beneath. The plant is a native of the Levant, Barbary, and the Mediterranean coast of Europe. It is said to be cultivated in Thuringia, in Germany; but this is probably a mistake. As described by HAYNE, the plant there cultivated is different from the *A. Pyrethrum* of LINNÆUS, and has been placed by the former botanist in a different genus, with the title of *Anacyclus officinarum*. It is an annual instead of a perennial plant, and though it may, as stated, produce a kind of pellitory used in Germany, is certainly not the source of the medicine usually kept in the shops under that name. The dried root of the *A. Pyrethrum* is the part employed as a medicine. (See *Pellitory*.)

Besides the species of Anthemis above described, two others have been noticed by medical writers—the *A. arvensis*, and *A. tinctoria*. The former is an annual plant, growing wild in Europe and this country, and bearing flowers which, though inodorous, have an acrid bitter taste, and possess medical properties resembling, but inferior to, those of common chamomile. The latter is a native of Europe, where it has been used as a tonic and vermifuge, but is wholly unknown in the United States. Its flowers are said to be employed to dye a yellow colour.

GEO. B. WOOD.

ANTHRACOSIS. (From ανθραξ, coal.) Ανθρακωσις, Gr.; *Anthracia*, *Carbuncula palpebrarum*, Lat.; *Charbon des paupières*, *Anthracose*, Fr.; *Augenbrand*, Germ. Anthrax of the eye-lids. This is a rare affection. The subjects of its attacks are principally the dregs of society, those who are ill fed, filthy, and addicted to intemperance, and persons in advanced life, though M. J. CLOQUET has met with it in a young peasant girl (*Dict. de Méd.* II. 459.). Its seat is most generally the upper lid. It presents itself in the form of a tumour of a dark red or purplish colour, accompanied with violent shooting, burning pain; grayish vesicles rise on its surface, which burst and discharge an ichorous matter; the cellular membrane and skin affected slough, and a cavity is left which is filled with sanies: often, according to WELLER (I. 120.), no vesicles form, but the tumour more or less speedily passes to a state of gangrene, sloughs out, and leaves a cavity which discharges a sanious humour.

The *causes* of this disease are the same as those of anthrax elsewhere.

The *prognosis* is usually unfavourable; for if death does not result from the consequent fever, the eye-lid may suffer a loss of substance, whence result a contraction and eversion of the part (*Lagophthalmia*), and sometimes even the loss of the eye.

No peculiar *treatment* is demanded for anthrax in this situation, except that care should be taken to keep the eye-lids closely approximated during the whole course of the healing process, in order to prevent their retraction and eversion. (See *Anthrax*.)

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I. HAYS.

ANTHRAX. (From ανθραξ, coal.) ανθραξ, Gr.; *Anthracia*, *Carbunculus*, *Persicus ignis*, Lat.; *Charbon*, Fr.; *Karbunkel*, Germ.; *Carbuncle*, Eng. This disease does not differ essentially from the common boil or furuncle, either in its cause, location, or career. Like that well-known affection, it may be caused by direct local irritations applied to the skin, or may follow, sympathetically, certain affections of the gastro-intestinal mucous surface. The formidable, and frequently fatal consequences of the complaint result from the greater extent of the parts involved, and the consequent severity of the febrile and other phenomena, which precede or follow its attack.

Furuncle (q. v.) is an inflammation of the cellular tissue occupying one of the conical or cylindrical areolæ of the cutis vera, and it terminates in gangrene of the part affected, in consequence of the strangulation of the tumour, by the firm fibrous envelope of the areola. In anthrax, the inflammation is extended to many proximate areolæ at the same time, all of which become gangrenous, and involve also the death of the fibrous partitions which divide them. The disease then, to use the words of MM. ROCHE and SANSON, consists in an agglomeration of furuncles. (*Nouv. Elém. de Pathologie.* I. 278.)

The parts most subject to anthrax are those in which the skin is thickest, and contains the largest portions of cellular

tissue within its substance; such as the neck, the back, the parietes of the thorax and abdomen, the nates, the thighs, the shoulders, &c., and it not unfrequently invades the jaw. The disease is not strictly confined to the skin, but frequently involves the subcutaneous tissue to a considerable extent, particularly in situations where this tissue is least lamellated in its arrangement, and perhaps no part of the surface is entirely exempt from its attacks. It appears as a very hard and painful tumour, well defined or circumscribed; of a deep red, or livid colour, surrounded by a circle of erysipelatous inflammation; the pain, as in all inflammatory affections of the skin, being of the burning character, and rapidly increasing in intensity, till the gangrene supervenes. It attacks the aged and debilitated, more frequently than the young and healthful. In females it occurs more frequently, about the period of the cessation of the menstrual flux.

The *causes* which predispose to this peculiar form of inflammation are not well understood, but they seem to be analogous to those which produce erysipelas phlegmonoides, and diffuse inflammation of the cellular tissue. Habitual excess in eating and drinking, not only increases the liability to anthrax, but renders it much more dangerous when it does occur. It happens occasionally as a sequence to herpes, the itch, measles, small-pox, and other cutaneous diseases; or it may be more immediately produced by punctures, friction, or any other local irritation to the skin. It is often preceded by lassitude, thirst, or foul tongue, fever, and the other customary marks of gastro-intestinal irritation, and it then makes its appearance without any obvious local cause. M. Marjolin remarks that it occurs more frequently in spring and autumn, than in summer and winter; which appears to prove that cold and dampness, and the vicissitudes of temperature, may contribute to its production. (*Dict. de Méd.* Ed. 2.) We have noticed a much greater liability to its appearance in seasons when there exists an epidemic tendency to erysipelas phlegmonoides, with which it is sometimes complicated. (See *Surgical Works of* John Jones, p. 173.) It is sometimes critical in fevers.

The *progress* of anthrax has been divided into three stages, that of the invasion, that of the maturation, and that of the ulceration of the tumour. The first stage commences frequently with a sense of itching in the part affected, and this is sometimes followed by severe lancinating pains before the tumour attracts attention. More frequently, the swelling is the first local symptom noticed, and the disease is generally mistaken for a boil or furuncle. The tumour rapidly increases, and the pain takes on a peculiarly severe, intense, burning character. Medical aid is then called in, and the surgeon finds a swelling presenting the appearances already noticed, which continues to increase in size for eight or ten days, and is then enlarged in some cases to an enormous extent. M. Marjolin (*Loc. Cit.*) mentions a case in which it involved more than one fourth of the surface of the neck, and another, in which it covered the greater part of the right flank. During this period, the pain increases continually, until, in severe cases, it becomes intolerable. Sleep is prevented, frequently spasms and delirium are induced, and gastro-intestinal irritation, with its usual consequences, makes its appearance, or, if it pre-existed, it is now greatly exacerbated. An erysipelatous circle often surrounds the tumour to the distance of many inches.

The second stage dates from the moment when the strangulation of the inflamed parts in the centre of the tumour has reached its maximum, and death of the cellular tissue in that place is produced. The suppurative process is now established, the skin over the most prominent point is gradually thinned, and at length several little vesicles appear, burst, and give exit, each, to a small portion of sanguinolent pus, generally of an unhealthy character. These vesicles are sometimes confluent, and resemble one large phlyctena. In furuncle, where but one of the cutaneous areolæ is affected with gangrene, a single orifice suffices to evacuate the pus; but in anthrax, where many are implicated at once, each requires to be separately discharged, for the fibrous partitions between the areolæ render the percolation of a fluid from one to another extremely slow and difficult, even after gangrene has taken place. In a few days, many of these orifices are fused into one, by the ulceration of the skin, and the discharge is increased in quantity. While the centre of the tumour is thus softened and converted into a slough, the mass continues hard for some time, and the circumference goes on enlarging. After a time, the whole interior of the tumour becomes gangrenous, the livid pellicle of skin which covers its circumference is thin and irregular, the orifice presents a large slough, of a whitish or gray colour, covered by an abundant discharge of pus resembling flour and water, and exhaling a fetid odour

of a peculiar kind. The suppuration surrounds the base of the tumour, distending the subcutaneous cellular tissue, which becomes involved in the gangrene to a greater or less extent, and when, in the third stage, the dead matter has been thrown off, layer by layer, the parts present the appearance of one wide ulcer, laying bare the aponeuroses, beneath which it occasionally penetrates, sometimes exposing the neighbouring muscles as completely as if they were dissected. The edges are thin, irregular, blueish, and indolent, remaining indisposed to, or incapable of, adhesion with the parts beneath. The loss of substance in severe cases is very great, and when the parts have cicatrized, the contraction consequent to the destruction of so much skin often occasions serious deformity and limits the motions of the part. The pain, which reaches its acme at the commencement of the second stage, continues, but gradually declines, till its conclusion.

The chief danger of the third stage consists in the exhaustion consequent upon the excessive discharge. The whole duration of the disease, calculated to the time when the sloughs are entirely separated, is commonly from twenty to thirty days, but no accurate limit can be set to the period required for cicatrization. Such is the usual march of the local symptoms in anthrax, unless some peculiarity in the treatment prevents their development.

There are, however, some other consequences, resulting from the particular situation of the tumour. These are, embarrassments of the functions of the neighbouring parts, produced by the excessive irritation and pain attending the disease, such as difficulty of deglutition, when the tumour is on the neck; dyspnœa, when it is in the same situation, or on the parietes of the thorax; obstinate constipation, when it is located upon the abdomen; &c. They require no further comment to render them intelligible. The disease is sometimes accompanied by an eruption of numerous furuncles, some of which may become involved in the tumour so as to increase its size, and occasionally, several tumours are found on the same patient at the same time. (Marjolin. *Op. Cit.*) Scattered petechiæ are noticed by Pearson as an occasional attendant on anthrax. (*Elements of Surg.* pt. I.)

Prognosis. The prognosis in anthrax depends much on the constitution and habits of the patient, but still more on the location of the tumour. Mild or small tumours situated on the back or extremities are rarely dangerous, and when large, the danger results either from the excessive nervous irritation, or from the exhaustion produced by the discharge. On the contrary, when anthrax is seated over serous cavities, even when moderate in size, it is extremely prone to produce inflammation of those cavities. This disposition is so remarkable in the head, that Sir A. Cooper declares he has never witnessed a recovery from anthrax on the scalp. Serious mischief is sometimes produced by the extension of the irritation to the nerves, when the tumour is seated over the spinal column, especially in the neck; and the œsophagus and trachea are endangered when they pass near the site of the disease.

Treatment. The apparent confusion observed in the practical directions of various authors who have treated on anthrax, seems to result, mainly, from a neglect of the various characters assumed by the disease in its different stages, and in patients of different constitutional peculiarities. No one plan of treatment is adapted to every case, and every stage, of anthrax. A strong distinction exists between those cases which are consequent upon some important visceral irritation, and those in which the tumour is the first obvious symptom. In the former, the relief of the primary visceral derangement should be the first object of the surgeon, nor can he reasonably anticipate success if he neglects it; while in the latter, the tumour is the most important subject of attention in the first instance; for the disordered actions of the various internal organs being a consequence of the local affection, they are most effectually corrected by the mitigation or destruction of their cause. Again; there is as great a difference between those cases which occur in persons whose constitutions are broken down by long-continued excesses in eating or drinking, and those which affect patients of moderate habits and a correct life. Where the former may require the internal exhibition of bark, wine, cordials, &c., as recommended by Pearson, Hosack, and many other writers who have preceded or followed them, the latter may recover much better under a rigorous diet, and local depletion, as prescribed by A. Perrez, and others of the physiological school. In the local treatment, also, the stimuli that may prove useful in the second and third stages of the disease, may be injurious in the first stage. No doubt every plan recommended

by surgeons of eminence has its valuable applications in some of the various conditions which have been mentioned.

The days have passed, when surgeons endeavoured to explain the obstinacy and fatal effects of these tumours, on the supposition that they result from a peculiar malignant virus in the system; and the general treatment of anthrax being now regulated on the same principles which should guide us in other severe local inflammations attended with similar constitutional conditions and accidents, we shall confine our remarks, at present, to the various *local remedies* and *modes of treatment* which have been prescribed in this disease.

a. *Repercussion by cold.* M. Marjolin remarks that he has seen a mild anthrax arrested in its progress, and the intolerable pain promptly relieved, by the application of compresses wet with very cold water. He objects to this remedy in cases consequent upon an internal cause, and adds, that it would speedily determine a gangrene of the part, if employed where the inflammation in the tumour is intense. (*Loc. Cit.*)

b. *Antiphlogistics.* It has been but too customary with some English and American surgeons to commence the use of stimulating washes and cataplasms, in the first stage of anthrax. The French, on the contrary, direct the patient to be placed on a very rigorous diet, and to drink freely of mucilaginous fluids, while warm and emollient washes are applied to the tumour during the height of the inflammation. When the disease is produced by an external cause, they endeavour to arrest its progress by the application of numerous leeches, encouraging the flow of as much blood as possible from the capillaries, by warm ablutions.

By some of the disciples of Broussais, this remedy is carried to greater lengths. Dr. Perrez published, in 1825, a most interesting case of anthrax, of large dimensions, treated successfully by repeated leeching, and rigid abstinence from all food; emollient drinks, only, being allowed. It is remarkable that the tumour in this case was preceded by gastric symptoms, of some continuance, and that mortification had taken place to a considerable extent before medical aid was called in. The patient was a female, aged 39 years, of a sanguineo-nervous temperament. She had very severe constitutional symptoms, convulsions, and a small, hard, and very frequent pulse. (*Ann. de la Méd. Physiologique.* VII. 583.)

Although it is difficult to believe that this plan of treatment would succeed in most cases of anthrax, and especially in such as originate from internal causes, it should be borne in mind, by those who would make a fair estimate of the value of local depletion in this disease, that long after the centre of the tumour has become gangrenous and commences to suppurate, the circumference often continues in a state of the highest inflammation, and may therefore require the employment of the same measures that are best suited to the first stage.

c. *Opiates.* The excessive pain produced by anthrax demands the attention of the surgeon, not only in consequence of the distress and loss of rest which it produces, but also because of the very serious sympathetic affections which it may engender in other parts, and the collapse which sometimes occurs in the worst cases. Patients have been known to die from the latter effect, in the first stage of the disease. Very great benefit sometimes results from the internal exhibition of opium; but it should be avoided, or given with great caution, when cerebral symptoms, or constipation are present. In such cases, relief sometimes follows the application of an opiate poultice, which should be thin and light, for the weight and pressure of cataplasms render them very troublesome to the patient.

d. *Incisions.* These have been employed in the treatment of anthrax, since the days of Ambrose Paré, if not at a still earlier period; but the manner and the purpose of the incisions have been very various, and this variety has been too much neglected by the opponents of the measure.

The plan of excision has had, and still retains, some advocates; but this proceeding cannot be resorted to, except when the tumour is small, and even then, its severity, and the fears of the patient, will seldom admit of its employment. Professor Lallemand resorts to a middle measure; he surrounds the tumour by a circular incision, for the double purpose of depleting the capillary vessels and relieving the strangulation of the parts. This incision is only applicable when the tumour is small, and when there is no danger of dividing any considerable artery or nerve. The portion of skin included in the circle, together with the subjacent cellular tissue, becomes gangrenous, and is thrown off in a slough. (Marjolin, *Loc. Cit.*) This method may very probably limit the extension of the anthrax, but it can have

little effect in relieving the strangulation of the inflamed parts; which arises, not from any general constriction of the whole mass, but from the unyielding character of the fibrous areolæ of the skin. This fact is indeed proved by the result, for if the constriction were removed, the gangrene would be prevented.

Decidedly the best form of incision is the crucial; and the credit of having first directed it for the express purpose of removing strangulation, is claimed, by his pupils, for M. Dupuytren. This form of incision was directed by many of the older surgeons, in the second stage of anthrax, for the purpose of evacuating the eschars and the pus. Its employment for this purpose was opposed by Lamotte, because there are many purulent depôts in anthrax, and they are not all opened by this operation. (*Traité Complet de Chirurgie.* t. 1. ed. 3.) Lassus advocates it for giving free access to the pus. (*Pathologie Chirurg.* t. 1.) In 1788, J. Pearson speaks of incisions and caustic as *justly exploded* (*Principles of Surgery.* pt. 1. 136.), yet they are now generally employed in England, and receive the sanction of Sir A. Cooper. (*Loc. Cit.*) M. Dupuytren resorts to the crucial incisions, even in the first or forming stage of anthrax. He carries them entirely through and beyond the edge of the tumour, and when it is very large, he makes additional incisions round the circumference, in the intervening spaces. After carefully pressing out the pus infiltrated into the cellular tissue, or inclosed in the skin, if any has been secreted, the wounds are dressed with simple emollient poultices; and if the patient's condition demands it, his strength is supported by some mild tonics or bitters. When the anthrax is attacked in time, and when it is effectually divided by the incisions, it is said never to terminate in gangrene. (Codet. *Diss. sur l'Anthrax.* p. 17.)

The success attending this plan of treatment, in the Hôtel Dieu, would amply warrant a far more general recourse to it, than has yet been made in the United States. A case is narrated by John Jones, of New-York, in which he speaks of the advantage gained by the crucial incision in alleviating the sense of constriction, prior to 1795 (*Surgical Works.* p. 173.); and the measures of Dupuytren were followed in several cases, with the happiest effect, at the Belleville Almshouse, between the years 1817 and 1821. (C. Drake, M. D. In *N. York Med. Repos.* N. S. VI. 462.) Yet it is evident that there must be many cases in which these incisions are inadmissible or impracticable, owing to the great extent, or the location of the disease; and it should not be forgotten that the relief of the strangulation and consequent pain is but partial, for many of the areolæ remain untouched by the knife, and inflammation may continue violent in the intervals of the incisions. This plan of treatment has been objected to, by many, on account of the increase of irritation produced; but this is certainly an erroneous objection. The local bleeding far more than compensates for the momentary increase of symptoms from the pain of the operation.

e. *Epispastics.* The treatment of anthrax by epispastics, may be considered purely American. Riverius, indeed, prescribed them long ago, as Dr. Beck observes, but appears to have employed them as counter-irritants, and applied them, not to the tumour itself, but to some neighbouring part. (*Obs. Med. Cent.* IV. 7.) Dr. Physick, who was the originator of this plan of treatment, seems now to repose less confidence in it than formerly. "From the great power of blisters in checking mortification," he remarks, "I once entertained high expectations of their utility in the treatment of anthrax. But though I have found them serviceable in abating the burning pain attending the inflammation, they have not shown any power in counteracting its progress to mortification." (*Phil. Journ. of the Med. and Phys. Sciences.* II. 175.) Still there is evidence enough to show that these remedies possess a high value in certain cases, and it is desirable that future observers should endeavour to determine the precise circumstances under which they prove most useful. Although they may sometimes accelerate rather than retard the mortification of the centre of the tumour, where they very seldom produce vesication, they appear to circumscribe the inflammation, and thus prevent the extension of the disease. The proper period for their employment would seem to be the commencement of the second stage, and the most suitable cases, those in which the extent or location of the tumour interdicts the use of the knife, and which show a strong tendency to spread indefinitely, or to become complicated with diffuse inflammation of the cellular tissue. A blister has been known almost immediately to cause a complete line of demarcation, when the mortification of an anthrax of the worst character was rapidly spreading. There is a most interesting anonymous case, of

this character, in the *N. E. Journal of Medicine and Surgery.* IX. 337.) The tumour was seated over the first cervical vertebræ, so as to extend some inches on the scalp. Very dangerous cerebral symptoms supervened, but they yielded readily to the blister. Drs. T. D. MITCHELL and J. B. BECK have also furnished us with some important observations illustrative of the use of epispastics in the treatment of anthrax. (See Bib. to this Art.)

As a means of affording temporary relief, Dr. PHYSICK informs us that he is in the habit of resorting to blisters, when anthrax is attended with that excessive pain which is compared by the patient to the application of burning coals. The relief they afford is great, but it rarely continues beyond twenty-four hours; their application may, however, be repeated as occasion requires. Dr. PHYSICK employs the blisters, under these circumstances, even in the first stage, or, to use his own words, "as soon as the disease is certainly known to be anthrax."

f. *Cautery.* The employment of caustics, in the cure of anthrax, is of very ancient date, and a variety of them have been recommended for this purpose. Arsenic was used as early as the days of AGRICOLA: LE DRAN employed corrosive sublimate, and RIVERIUS, some others. CELSUS depended mainly upon the actual cautery, which he applied after dividing the eschar, so as to permit the heat to act upon the living parts beneath. It would be more curious than useful to relate the opinions and arguments of the supporters and opponents of this plan of treatment. Suffice it to say, that the greatest objection advanced against it—the severity of the application—is more specious than real. It must be remembered that in this disease, the extreme branches of the nerves of feeling are inflamed and pressed on in such a manner as to experience the highest possible degree of irritation, for this irritation goes on increasing until it deprives them of life: how then can a remedy which accomplishes the destruction of these parts almost instantaneously, produce more pain than the slower torture of the disease! We have had occasion to witness the application of the actual cautery, in several cases of severely painful disease, notwithstanding the very infrequent employment of this measure in America, and we can bear testimony to the fact that the application of an iron at a white heat, produces very little pain: at a less temperature, its effects are indeed severe, because it does not then destroy the cutis instantaneously. Surely there can be no more effectual mode of removing the mechanical causes of the violence of this disease, than the destruction of the parts by cautery, after all hope of resolution is at an end. Many authors object to cautery when the disease affects the face, for the same reason that MARJOLIN proscribes incisions under the same circumstances, to wit, because of the deformity likely to result from the application! This is strange; for neither remedy is advocated except in cases which are, or will inevitably become, complicated with gangrene, which accident must induce still greater deformity, if the case is left to nature. The happy effects of the actual cautery, employed after the manner of CELSUS, are illustrated in a case of anthrax of the face, by M. POUTEAU. (*Œuvres Posthumes.* II. 515.)

The potential cautery is considered by many as more painful than the actual; and from the few instances in which we have employed or witnessed the application of the latter, we have been inclined to the same opinion; but the highest surgical authority in America stands in some degree opposed to us. Dr. PHYSICK thinks that the rapidity of action displayed by the caustic potash, which certainly renders it much less severe than any other agent of the same class, is productive of less suffering to the patient than even the heated iron. Cæteris paribus, the alkali will always receive a general preference to the iron, in this country, because of the terror inspired in the patient by the latter measure, and the natural aversion of the surgeon to a plan of treatment so alarming to the friends and attendants. But there is still another and a stronger argument advanced by Dr. PHYSICK. He thinks that the ulcers resulting from burns are always unhealthy, and peculiar; whereas those that follow the application of caustic potash are simple, healthy, granulating sores. The former have a strong tendency to form irregular callous rugæ in the cicatrices, and almost always heal with difficulty. The latter, on the contrary, cicatrize readily, and leave a smooth surface, productive of little deformity. (See *Burns.*) He has therefore recommended, and continues to employ, the caustic alkali, in preference to the actual cautery, in the treatment of anthrax. The proper time for the application of this remedy is the commencement of the second stage, when the orifices begin to form in the

skin; and it should be carried to such an extent as to destroy the vitality of all that portion of the *cutis vera* which would necessarily become gangrenous if it were omitted. We are indebted for this view of his opinions, to the politeness of Dr. PHYSICK himself.

The use of caustic at an early period, when all stimulating applications are injurious, Dr. PHYSICK considers as the chief cause of the opposition raised against it. (*Loc. Cit.*) A moment's reference to the pathology of the disease will show the admirable adaptation of this remedy to the complaint. The degree of relief experienced from it may be fairly judged from the history of the case of the late Mr. Wharton. "At this period," i. e. at the commencement of the second stage, on the morning of the tenth day, says Dr. PHYSICK, "I suggested the application of the vegetable alkali upon the middle of the tumour, for the purpose of destroying all that part of the skin perforated by the orifices just mentioned. This was immediately submitted to, and an eschar formed, of about two inches in diameter. The pain from the caustic ceased in a quarter of an hour, and from that time Mr. Wharton *suffered no pain whatever from the disease*," &c. (*Loc. Cit.*)

g. *After-treatment.* During the whole course of the complaint, care should be exercised to keep the bowels as regular as possible; and when the sloughs are separating, and after they have been detached, it is often necessary to support the strength of the patient with mild tonics, and sometimes with cordials and stimulants. If neither incisions nor caustic have been resorted to, the edges of the ulcer are ragged, thin, bluish, and ill disposed to unite with the parts beneath; they should then be removed, either by the knife or by caustic. The ulcer should be treated upon general principles, as it has nothing peculiar in its character. (See *Ulcer.*) Particular care is necessary in lessening as much as possible the deformity and embarrassment of motion resulting from the loss of substance. (See *Cicatrix.*)

The term anthrax has been applied to certain other tumours, especially to the bubo (q. v.), which occurs in plague, &c., but there is little in common between these affections.

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RICHTER. *Anfangsgr. de Wundarzn.* b. 1

REYNELL COATES.

ANTHROPOLOGY. (From ανθρωπος, man, and λογος, discourse.) A discourse or treatise on man, or the science of human nature. In its fullest application, Anthropology is the history of man as a part of creation, whether he be considered in reference to his organization, his physiological endowments, his intellectual and moral attributes, or the zoological position he occupies in the great scale of animal existence. In this acceptation it is a kind of generic term, embracing the entire history of man, both corporeal and spiritual, in all his multifarious relations. Considered in reference to the physical organization of man, anthropology becomes merged in anatomy; when applied to the investigation of his vital economy, it identifies itself with physiology; and when its object is his intellectual and moral endowments and relations, it naturally becomes blended with psycology or metaphysics, and may hence be made to embrace the doctrines of theology, ethics, jurisprudence, politics, &c.

A much better plan is to limit the term, as has been done by some writers, to the natural history of man, and to employ the word anthropology in reference to this subject, in the same manner that the terms ornithology, entomology, conchology, &c., are used to designate the natural history of birds, insects, and the molluscous animals. For the details of the subject considered in this manner, see *Man*.

E. Geddings.

ANTHROPOMORPHOUS. (From ανθρωπος, man, and μορφη, form.) Having the human form. I. H.

ANTHROPOTOMY. (From ανθρωπος, man, and τομειν, to cut.) Literally, the dissection of the human body. In its more common acceptation, the term anthropotomy is synonymous with anatomy, and is employed to represent human anatomy, in contradistinction to zootomy, which is the anatomy of animals. E. G.

ANTI, and, by abbreviation, for the sake of euphony, ANT. (From αντι, against.) Opposed or contrary to. This preposition, prefixed to an adjective, serves, in therapeutics, to designate the measures suitable for the cure of a disease or removal of a symptom. Thus, antiphlogistics, are the measures employed for the cure of inflammations, &c. Anti, in this view, is synonymous with remedies or therapeutic agents.

The expression anti, is sometimes used to indicate remedies which possess a constant efficacy against certain affections, as in the words anticancerous, antisyphilitic, &c.; it is here synonymous with specifics (q. v.).

To constitute a class of remedies, it is necessary that there should be an analogy between the individuals which compose it. Such analogy is, however, rarely met with; and moreover, the phases of diseases are so various, that remedies suitable in one stage or to one person, are inapplicable in another stage or to another person, and to effect a cure it is necessary to have recourse to a different class of therapeutic agents. Hence, but few of these classes should be admitted, and we shall accordingly reject all but those which appear well founded, or the epithets applied to which are so commonly employed that a definition will be expected; the others will be treated of in the articles on the several diseases, to which, indeed, they really belong; for the employment of all remedies involves pathological considerations from which the therapeutic cannot be separated without inconvenience.

I. Hays.

ANTIDOTE. (From αντι, against, and διδοναι, to give.) Antidotes are substances which, when administered, have the power of rendering poisons inert, or at least devoid of danger. According to its etymology, the term would include every remedy which might with propriety be employed in cases of poisoning; but in its modern acceptation, it is restricted to such agents only, as have the power, to a greater or less extent, of acting chemically on poisons in the stomach, with the effect of destroying their dangerous properties. Agreeably to this definition, the nature of such bodies is more correctly conveyed by the term *Counter-poisons*.

According to Orfila, the first authority on this subject, *antidotes* or *counter-poisons* should possess the five following properties:

1. They should admit of being taken in large doses without danger.
2. They should act on the poison at or below the temperature of the body.
3. Their action should be prompt.
4. They should have the power of combining with the poison in the midst of the gastric, mucous, bilious, and other fluids, which the stomach is likely to contain.
5. And lastly, in acting on the poison, they should possess the power of depriving it of all deleterious properties.

In investigating the subject of antidotes, toxicologists have instituted a great number of experiments on inferior animals. To guard against erroneous conclusions, it is necessary in these experiments, after

the ingestion of the poison and the antidote, that the œsophagus of the animal should be tied; as otherwise vomiting might produce a relief, which would be erroneously attributed to the influence of the antidote. Even when the experiment is thus performed, ORFILA cautions us against drawing too hasty a conclusion; as the results are rendered ambiguous by the varying degree of vitality of the animal experimented on, as well as by the effects of the ligature itself.

The number of antidotes as yet discovered is but limited, compared with the great number of poisons known; and those which are recognized as such, act with various degrees of power and promptitude, even when given under the most favourable circumstances.

The different recognized antidotes will be noticed in this place, only in a general manner; because they are necessarily treated of, in detail, under the head of the different poisons against which they are used.

The substances for which antidotes, more or less efficient, have been discovered, are, 1. mineral acids; 2. oxalic acid; 3. fixed alkalies; 4. ammonia; 5. alkaline sulphurets; 6. alkaline earths; 7. the salts of the following metals; viz. antimony, silver, copper, lead, tin, and mercury. To this list may be added opium and its preparations.

Mineral Acids. These acids, embracing the sulphuric, nitric, and muriatic, act with extreme promptitude, and require the application of antidotes with the least possible delay. The best antidote which can be employed is calcined magnesia, which acts by neutralizing the particular acid, converting it into a saline combination which is comparatively innocuous. But as the greatest danger arises from the least delay in the application of remedial measures, and as magnesia is not always to be had immediately, it will be the duty of the practitioner to use less efficient antidotes, until that earth can be procured. Accordingly, in the interim, strong soap suds, or soft soap and water, should be administered freely. If these are not at hand, the patient should be made to swallow large quantities of mucilaginous drinks, of milk, or even of warm or cold water, while the magnesia is being procured. When this is obtained, the patient should be gorged with water in which the earth has been plentifully stirred. The carbonate of magnesia, though highly useful in the absence of the pure earth, is less convenient than the latter; as its employment gives rise to a prodigious distension of the stomach, in consequence of the extrication of carbonic acid.

Oxalic Acid. From the fearful rapidity with which this poison acts, it has generally produced fatal mischief before assistance can be afforded. The proper antidotes in poisoning by this acid are chalk and magnesia, speedily given, in large doses suspended in water. They act by forming with the poison an insoluble oxalate of lime or of magnesia. In case the appropriate antidotes are not at hand, the practitioner may, while they are being procured, administer an emetic; but Dr. CHRISTISON cautions against the administration of warm water, as, in his opinion, the dilution of the poison will promote its absorption, and thereby increase its deleterious effects; unless free vomiting should speedily occur, which is not always produced by giving warm water.

Fixed Alkalies. The only fixed alkalies which are known to act as poisons are potassa and soda. Lithia, though probably poisonous in the caustic state, has not been experimented upon with a view to its effects. The combinations in which potassa and soda are caustic and poisonous, are the hydrates and carbonates, known under the names of caustic potassa and soda, carbonate of potassa, (potash, pearlash, and salt of tartar,) and carbonate (subcarbonate) of soda.

The proper antidote for these alkalies, according to ORFILA, is vinegar, very much diluted, and taken in large quantities. It acts not only by neutralizing the poison, but by favouring its expulsion by vomiting. If vinegar should not be at hand at the first moment of the accident, the patient should be gorged with simple water, or some mucilaginous drink, until vinegar and water can be procured. According, however, to M. CHEREAU, sweet oil is a preferable antidote to vinegar. It acts partly by rendering the vomiting more easy, and partly by converting the poison into soap. When oil is employed, it usually requires to be given to the extent of several pounds.

Ammonia. The same antidotes applicable to the treatment of the fixed alkalies, are also proper here. Unfortunately, however, this alkali, in the caustic liquid state, acts with such extreme promptitude, that very little can be hoped from the use of antidotes.

Alkaline Sulphurets. These sulphurets, the principal of which is the sulphuret of potassa, sometimes called *liver of sulphur*, act as poisons probably in consequence of

the rapid disengagement in the stomach of sulphuretted hydrogen, which is a highly poisonous gas. The proper antidote is chloride of soda, or chloride of lime, (bleaching salt,) given in solution. It acts by decomposing the poisonous gas, the chlorine of the antidote uniting with its hydrogen, and precipitating the sulphur. While the antidote is preparing, some diluent must be administered in large quantities without the least delay.

Alkaline Earths. The alkaline earths for which antidotes are known are lime and baryta. Those for lime are precisely the same as for the fixed alkalies, enumerated above. The antidote for baryta, or its soluble salts, particularly the muriate, which is very poisonous, is a soluble sulphate, which acts by converting the earth into the insoluble sulphate of baryta. Accordingly, in the treatment of these cases, weak solutions of sulphate of soda, or of sulphate of magnesia, should be given; but at the same time, the expulsion of the poison should be attempted by titillating the throat with a feather, or by the administration of an emetic.

Salts of Antimony. The principal salt of antimony, and that most likely to produce poisonous effects, is tartar emetic. In treating a case of poisoning by this salt, Orfila advises, provided the patient has vomited freely soon after the ingestion of the poison, and is not affected with sharp pains, that warm water should be administered freely. In case vomiting has not taken place, it must be induced, if possible, by immediately titillating the throat with a feather, and by the administration of abundance of warm water. Sweet oil sometimes favours vomiting, and may be useful. If, notwithstanding the employment of these measures, vomiting is not produced in a short time, recourse must be had to a warm decoction of yellow Peruvian bark, freely given, which acts as a proper antidote, by decomposing the poison and rendering it comparatively inert. This antidote was proposed by Berthollet, and Orfila reports two cases in which its use was attended with complete success. Until the decoction is prepared, the bark in substance, diffused in water, should be given. If the bark is not at hand under circumstances which would render its employment expedient, it will be proper, until it is procured, to use, as a substitute, a decoction either of galls, of some astringent root or bark, or of common tea. All these vegetable substances act as antidotes on the same principle, namely, that of decomposing the poison, and precipitating the protoxide of antimony in union chiefly with tannin.

Orfila says that the alkaline sulphurets should be rejected as antidotes for tartar emetic. Nevertheless, the late Dr. Duncan asserted that he used for this purpose the sulphuret of potassa with perfect success.

Salts of Silver. All the soluble salts of this metal are decomposed completely by common salt, which causes a precipitate in them of the insoluble chloride of silver. Of the salts of this metal, the nitrate only is likely to be taken in a poisonous dose; and when called to such a case, the physician should administer a weak solution of common salt in large quantities.

Salts of Copper. The best antidote for these salts has been ascertained by Orfila to be albumen, which possesses the property of decomposing all the soluble salts of copper, and destroying their deleterious properties. Called to a case of poisoning by copper, the physician should administer a solution of the whites of eggs in repeated doses, until the stomach is filled with this liquid, when vomiting will probably occur. Until eggs can be procured, the patient should be gorged with water, and made to vomit, if possible, by exciting the throat with a feather or the finger.

Orfila has obtained equally favourable results from the use of the ferrocyanate (prussiate) of potassa as an antidote for the cupreous poisons, as from the employment of albumen. It acts by throwing down an insoluble ferrocyanate of copper. But as this antidote is not so easily procured as eggs, and is apt to produce vertigo when given in large doses, it is less eligible than albumen.

Sugar, announced by M. Marcelin Duval as an antidote to the poison of verdigris, has been proved by Orfila not to possess that character, but merely to act as a calmer of irritation.

Salts of Lead. Orfila has proved that the sulphate of magnesia, when taken in sufficient quantity, is a true antidote to the poison of acetate of lead (sugar of lead) recently taken in an over-dose. It acts by producing in the stomach, by double decomposition, the insoluble sulphate of lead, which is inert. The same toxicologist infers from these facts that the sulphate of magnesia would be equally efficacious in destroying the poisonous effects of the other soluble salts of lead. For the poison of lead, as displayed in its remote effects, in the affections called lead colic and lead palsy, no antidote is known.

Salts of Tin. The only salt of this metal likely to prove poisonous is the muriate; and for this, Orfila has discovered that milk is a complete antidote. This animal liquid combines with the salt, and becomes converted into thick curds. It is to be administered in large quantities, mixed with water.

Salts of Mercury. The only preparation of mercury important as a poison is the deutochloride, or corrosive sublimate. To Orfila belongs the merit of having discovered that albumen or the white of eggs is a proper antidote to this energetic poison. It acts by converting the corrosive sublimate into calomel, with which the albumen then combines. Accordingly, the first measure to be taken by a practitioner called to a case of poisoning by corrosive sublimate, is to give several glasses of the whites of eggs, mixed with water. If eggs are not to be procured immediately, the interval, until they are obtained, should be occupied with the administration of flaxseed tea, rice water, sugar and water, gelatinous broths, or even simple warm water. These diluents distend the stomach, and by favouring vomiting, promote the expulsion of the poison.

Hydrosulphuric acid (sulphuretted hydrogen), sugar, Peruvian bark, mercury, charcoal, and broth, have all been proposed as antidotes to corrosive sublimate; but Orfila has proved that none of these substances deserve that title. The gluten of flour, proposed in 1822 by M. Taddei as an antidote for this poison, is admitted by Orfila to be useful, but nevertheless inferior to albumen.

Opium and its Preparations. The antidotes which have been proposed for opium are 1. coffee; 2. camphor; 3. chlorine water; 4. vinegar and vegetable acids; 5. water and mucilaginous drinks; 6. decoction of galls. Coffee and camphor have no effect as antidotes, though useful in combating the effects of this poison. Chlorine water is itself an acrid poison, when given of sufficient strength to decompose the opium in the stomach. Vinegar and vegetable acids are not antidotes, since they have no power of decomposing the poison and destroying its dangerous qualities; and their effects are diametrically opposite, according as they are given before or after the expulsion of the poison by vomiting. If before, they are hurtful by promoting the solubility, and therefore absorption, of the opium; if after, they prove useful by diminishing the symptoms caused by the poison. These remarks apply equally to water and mucilaginous drinks.

The decoction of galls may be viewed in the light of an imperfect antidote to the preparations of opium; since it has the power of producing a precipitate with them which is much less active than the opium itself. Accordingly, Orfila recommends, in cases of poisoning by opium, the administration of this decoction in repeated doses. A detailed account of the other measures necessary to be pursued in cases of poisoning by opium, would be out of place under the head of Antidotes, and will be given under the article *Opium*, to which the reader is referred.

There still remain a number of poisons for which antidotes are not known. The alkaline sulphurets, sulphuretted hydrogen, acetic acid, charcoal, and lime-water have been recommended as antidotes for arsenic; but Orfila declares that they are all without any efficacy, except the last, which may be useful, in case the poison has been taken in a state of solution, by forming with it the insoluble arsenite of lime. But, as Orfila truly remarks, inasmuch as arsenic is almost always taken in the solid state, lime-water can rarely be of any use. Hydrocyanic acid, like arsenic, has no antidote.

Franklin Bache.

ANTIEPHIALTICS. (From αντι, against, and εφιαλτης, nightmare.) Remedies for nightmare (q. v.). I. H.

ANTIHELIX. (From αντι, before, and ελιξ, the helix.) An eminence of the cartilage of the ear, in front of the helix, extending from the concha of the auricle to the groove of the helix, where it terminates insensibly in a bifurcation. I. H.

ANTIHYPNOTICS. (From αντι, against, and υπνος, sleep.) Remedies against sleep or drowsiness. Natural sleep ought rather to be favoured than repelled; but on some occasions, persons wish to keep awake, and this is usually accomplished by the use of stimulants, as coffee, tobacco, &c. Morbid sleep, somnolence, coma, (q. v.), arises from various causes, and the measures resorted to for its cure must of course have reference to its cause. There is no class of remedies entitled to the epithet antihypnotic. I. H.

ANTILITHICS. (From αντι, against, and λιθος, a stone.) These are medicines which have a tendency to prevent the deposition of calculous matter in the kidneys or bladder, or to dissolve it when deposited. It was formerly believed that stone in the bladder might be destroyed by the

agency of substances taken into the stomach, and to these substances the name of Lithontriptics was applied; but, to say the least, such a power has never been proved to be possessed by any medicine, and certainly, therefore, cannot properly serve as the basis of a class. Still, the painful effects of the stone may be considerably alleviated, and its increase, perhaps, in some instances, prevented or restrained; and there can be no doubt, that the disposition of the kidneys to secrete, or of the urine to deposit in the bladder calculous matter in the form of sand or gravel, may often be completely corrected by certain remediate measures. It has been thought by some who reject the lithontriptics, that the medicines calculated to produce these effects might, with propriety, be associated into a class with the name of Antilithics, which merely expresses their efficacy in relieving calculous affections, without indicating their mode of action. But to such an association, as to all others founded on certain pathological conditions, it may be objected, that, as these conditions often depend upon different causes, are variously modified by circumstances, and require diversified and sometimes complicated modes of treatment, the remedies employed must vary, and can possess no sufficient resemblance or unity of properties to authorize their arrangement into a distinct group. In relation to the antilithics, this will be rendered obvious by the few general remarks which it is deemed proper to make upon the medicines embraced under that title.

In certain morbid states of the system, the uric or lithic acid, which is a constant ingredient of the urine in its healthy state, is thrown off by the kidneys in unusual abundance, and, as it can be held in solution by the urine only in moderate quantities, is deposited either uncombined, or in connexion with a portion of ammonia or other alkaline base, usually in the form of a reddish sediment. The disposition of the system which leads to this result, it is customary to denominate the uric or lithic acid diathesis. As the acid is rendered soluble by an excess of alkali, it is obvious that alkaline remedies are here the best correctives of the calculous symptoms; for, by entering the circulation, and passing out with the urine, they enable this liquid to hold in solution the substance which would otherwise be deposited.

In the urine of a person in health, the uric acid is held in solution through the agency of the alkaline bases with which it is combined. As it has but a feeble affinity for these bases, almost any acid which may be secreted by the kidneys, will, by depriving it wholly or in part of the alkali, diminish its solubility, and frequently cause its deposition. The existence of acid, in large quantity, in the primæ viæ, will, therefore, often give rise to gravel, in consequence of the absorption of the acid, its passage into the circulation, and its evolution by the kidneys. The best antilithics are, here also, obviously, the alkalies and alkaline earths, which neutralize the acid in the stomach and bowels, and consequently prevent its absorption.

But the presence of an excess of acid in the alimentary canal, is very often owing to a debilitated or dyspeptic condition of the stomach, which may be corrected by the employment of gently excitant remedies. Hence, tonics and astringents are occasionally useful as antilithics.

There is reason to believe, that, in morbid conditions of the system attended with an increased production of acid, nature has provided that it should be thrown off partly by the skin, and its accumulation in the circulation, or undue direction to the kidneys, thus prevented. Whatever, under these circumstances, checks perspiration, must have a tendency to produce gravel, by directing the superabundant acid into the urine; and the restoration of the function of the skin is clearly indicated as a remedial measure. Hence diaphoretics are sometimes useful in calculous complaints.

Not unfrequently a state of system exists which leads to the deposition of the insoluble phosphates in the urine, and is therefore sometimes designated as the phosphatic diathesis. The phosphoric acid, existing in the urine, in a healthy state, is variously combined with alkaline or earthy bases, and held in solution by a nicely balanced play of affinities, which may be readily disturbed. The presence of an alkali in excess will produce a precipitate of the insoluble phosphates; and the habitual use of alkaline medicines sometimes occasions a deposition of this kind of calculous matter. An acidulous state of the urine, on the contrary, has a tendency to keep the phosphates in solution. Acids, therefore, prove antilithic in this form of gravel, both by preventing an excess of alkali in the urine and by their own solvent power.

The phosphatic diathesis is often associated with weak digestion, general debility, and a deranged condition of the nervous system; and these are sometimes

perhaps, the immediate cause of the unhealthy action of the kidneys. Hence tonics and narcotics sometimes display antilithic properties.

When the calculous complaint is connected with diminished secretion of urine, there is an obvious indication for mild diuretics with the copious use of demulcent drinks, in order to dilute the urine and thus increase its solvent power. These, therefore, may be added to the long list of antilithics.

Finally, inflammation of the kidneys, acute or chronic, or a degree of irritation short of absolute inflammation, may so derange the action of these glands as to occasion the production of gravelly urine. Consequently the antiphlogistic remedies may prove antilithic; and it is probably by their direct action upon the kidneys, in a state of chronic inflammation or ulceration, that certain stimulant diuretics, such as copaiba and the turpentines, are occasionally useful in affections which pass under the name of gravel.

From this sketch it may be seen, how exceedingly diversified are the remedies entitled to the name of antilithic, and how impossible it would be to associate them in a single class, characterized by any one common property. Of the alkaline antilithics, those most commonly employed are the *carbonates and bicarbonates of soda and potassa, magnesia and its carbonate*, and *lime* in the form of *lime-water.* The bicarbonate of soda, perhaps, deserves the preference both for the comparative mildness of its taste, and the promptness and certainty of its action. It is most agreeably administered dissolved in carbonic acid water, with or without a little ginger syrup. The acids usually employed as antilithics are the strong *mineral acids*, such as the *nitric*, *muriatic*, and *sulphuric*. Hard *cider* sometimes exercises a happy influence in gravel, probably through the agency of its acetic acid. The most useful diaphoretic is the officinal *powder of ipecacuanha and opium*, commonly called Dover's powder. *Gentian*, *quassia*, *hops*, and *uva ursi*, are among the tonics and astringents which have been particularly recommended in gravel. *Opium* is the most efficient narcotic. A list of all the antilithic remedies, and a precise account of the circumstances under which they may be most advantageously employed, belong to a therapeutical treatise on calculous disorders. GEO. B. WOOD.

ANTIMONY. (From the Greek αντι, against, and French *Moine*, Monk; in allusion to the fact that when first used as a remedy, it was frequently given by the monks to their brethren, in hazardous doses.) *Regulus of antimony; Antimonium, Stibium*, Lat.; *Antimoine*, Fr.; *Antimon, Spiessglas*, Germ.; *Antimonio*, Span., Ital.

The number and importance of the medicinal preparations of this metal render it proper that it should be treated of at considerable length. As an object of attention by the physician, it deserves to be particularly studied in its chemical, pharmaceutical, therapeutical, and toxicological relations. We shall, accordingly, treat of it under the four following heads: 1. Chemical history; 2. Pharmaceutical preparations; 3. Effects on the system and therapeutical applications; and 4. Toxicological effects, and tests.

§ I. CHEMICAL HISTORY. The ores of this metal were known from an early period; but BASIL VALENTINE was the first who made mention of its reduction to the metallic state, in a work entitled *Currus Triumphalis Antimonii*, published towards the close of the fifteenth century. Of all the metals, it was the one which attracted the greatest share of attention from the alchemists, and which was subjected by them to the greatest number of experiments. Since their time, it has been an object of research with a number of the best chemists, notwithstanding whose labours its chemical history is still incomplete.

Natural State and Mode of Extraction. Antimony occurs native, in the state of oxide, abundantly as a sulphuret, and rarely as a sulphuretted oxide. It is found in nearly all countries, but most abundantly in France and Germany. It is from the native sulphuret that the antimony of commerce is extracted. The process pursued in France consists in first fusing the ore, in order to separate the sulphuret from stony and earthy impurities. It is then reduced to powder and carefully roasted, whereby, in consequence of the dissipation of nearly all the sulphur, and the absorption of oxygen, it is converted into an oxide of a dull grayish-white colour. This is then mixed with tartar, or with charcoal impregnated with a concentrated solution of carbonate of soda, and exposed to heat in crucibles, in a melting furnace. The charcoal employed, or that derived from the decomposition of the tartar, reduces the oxide; while the alkali unites with, and separates, any small portion of sulphuret which may have escaped the decomposing influence of the heat. The metal obtained is then purified by a second fusion. The antimony prepared in France

is most esteemed, and is that which is principally received in the United States.

Properties, &c. Antimony is a brilliant, brittle metal of a lamellated texture, of a silver-white colour when pure, but bluish-white as it occurs in commerce. When rubbed, it exhales a peculiar odour. Its specific gravity is 6.7, and fusing point, 810°, or about a red heat. On cooling, after fusion, it assumes a crystalline texture, and an appearance on the surface, resembling the fern leaf. When strongly heated, it takes fire, and burns with emission of copious white vapours, which condense in a brilliant, white, crystalline powder, formerly called *argentine flowers of antimony*, which, according to Thenard, consist of protoxide. When a small portion of the metal is fused, and thrown from a moderate height, it separates into numerous burning globules, which leave a white trace wherever they roll. This metal forms three combinations with oxygen, one oxide,—the *protoxide*, and two acids, —*antimonious* and *antimonic acid*. According to Berzelius, its equivalent number is 64.6; and the oxygen in its oxide and acids, is in the ratio of the numbers $1\frac{1}{2}$, 2, and $2\frac{1}{2}$. Antimony also forms three sulphurets, which are proportional, as to the sulphur which they contain, to the three combinations with oxygen.

Combinations with Oxygen. The *protoxide* may be obtained by oxidizing antimony by means of nitric acid, and digesting the resulting compound repeatedly with water, until this liquid, poured off from it, is no longer capable of reddening litmus. The protoxide, thus obtained, is in the form of a powder of a dirty white colour. It consists of one equivalent of antimony 64.6, and one and a half of oxygen 12 = 76.6. *Antimonious acid*, sometimes called deutoxide of antimony, is procured by oxidizing antimony at the expense of nitric acid, evaporating the mass to dryness, and calcining the residue; or by roasting the sulphuret of antimony, until the whole of the sulphur is separated. It is a powder of a snow-white colour, which becomes yellowish on the application of heat. It consists of one equivalent of metal 64.6, and two of oxygen 16 = 80.6. *Antimonic acid*, called by some chemists the peroxide, may be formed by dissolving the metal in nitro-muriatic acid, evaporating the solution to dryness, adding to the residue concentrated nitric acid, and heating the mass at a temperature somewhat under redness, until all the nitric acid is expelled. Antimonic acid is an insoluble, tasteless powder, of a pale yellow colour when pure, but deep yellow when contaminated with nitric acid. When exposed to a full red heat, it loses oxygen, and is converted into antimonious acid. It is soluble in a boiling solution of caustic potassa, from which it may be precipitated by acids as a white hydrate, in which state it is slightly soluble in water and reddens litmus. It consists of one equivalent of antimony 64.6, and two and a half of oxygen 20 = 84.6. These acids form with bases, salts severally called *antimonites* and *antimoniates*.

Chlorides. Antimony forms three chlorides, which are considered to correspond in composition with its three oxides and sulphurets. One of them is used in medicine, and will be noticed hereafter under the pharmaceutical preparations of the metal. The other two are not of sufficient importance to be described.

The above sketch may serve to give the reader a general idea of the chemical properties and most important combinations of antimony. With regard to the properties of its numerous medicinal preparations, these will necessarily be given under the following head.

§ II. Pharmaceutical Preparations. The preparations of antimony which have been and are still used in medicine are exceedingly numerous; and to notice them all would lead to tedious details, not profitable to the medical reader. The following table may be considered as embracing those pharmaceutical preparations of antimony, which deserve particular notice. It contains nearly all those to be found in the French Codex, and in the British and United States Pharmacopœias.

Antimony is used,—

Sulphuretted:

1. *Sulphuret of Antimony.* Antimonii Sulphuretum. Ph. U. S.
2. *Prepared Sulphuret of Antimony.* Antimonii Sulphuretum Præparatum. Ph. U. S.
3. *Kermes Mineral.* Hydrosulfuretum Rubrum Stibii Sulfurati. Cod. Gall.
4. *Golden Sulphur of Antimony.* Hydrosulfuretum Luteum Oxidi Stibii Sulfurati. Cod. Gall.
5. *Precipitated Sulphuret of Antimony.* Antimonii Sulphuretum Præcipitatum. Ph. U. S.

Combined with Chlorine:

Butter of Antimony. Deuto-Murias Stibii Sublimatus. Cod. Gall.

Oxidized:

1. *Powder of Algaroth.* Antimonii Oxydum Nitro-Muriaticum. Ph. D.

2. *Diaphoretic Antimony.* Oxidum Stibii Album. Cod. Gall.

Oxidized and combined with Sulphuret:

1. *Glass of Antimony.* Antimonii Vitrum. Ph. L.
2. *Crocus of Antimony.* Oxidum Stibii Sulfuratum Semivitreum. Cod. Gall.

Oxidized and combined with Sulphuric Acid:

Subsulphate of Antimony. Sub-Sulfas Stibii. Cod. Gall.

Oxidized and combined with Tartaric Acid and Potassa:

Tartar Emetic. Antimonii et Potassæ Tartras. Ph. U. S. et D.

a. Dissolved in wine. *Antimonial Wine.* Vinum Antimonii. Ph. U. S.

b. Mixed with lard. *Tartar Emetic Ointment.* Unguentum Tartari Emetici. Ph. D.

Oxidized and mixed with Phosphate of Lime:

Antimonial Powder. Pulvis Antimonialis. Ph. L. et D.

These various preparations will be noticed in succession, and more or less fully according to their relative importance.

Sulphuret of Antimony. (Crude Antimony.) This is obtained from the native sulphuret by a process of purification, the object of which is to separate the earthy and stony impurities, with which the natural ore is associated. The best method for effecting this object is to place the pounded ore in slightly conical earthen tubes, fixed vertically in a kind of reverberatory furnace. Heat being applied, the sulphuret, the only part fusible of the ore, will melt, and may be received below in a proper recipient, while the impurities remain behind.

This preparation, sometimes called *antimony*, and *artificial sulphuret of antimony*, occurs in commerce in fused, roundish masses, called loaves, of a dark-gray colour externally, and of a brilliant steel-gray colour and radiated or fibrous texture within. Their goodness depends upon their compactness and weight, the largeness of the fibres, and their total volatility by heat. The quality of the sulphuret cannot be judged of except in mass, and hence it ought not to be bought in powder. The powder of the pure sulphuret is reddish-brown; that of the commercial sulphuret, almost always black. The most usual impurities are lead, iron, and arsenic. Lead is detected by the texture of the loaves being foliated; iron, by the production of a brown colour by deflagration with nitre; and arsenic, by the occurrence of an alliaceous smell, when the sulphuret is heated. This sulphuret consists of one equivalent of antimony 64.6, and one and a half of sulphur 24 = 88.6. It is, therefore, a *sesquisulphuret.*

Sulphuret of antimony is the parent of nearly all the antimonial preparations, being the chief material from which they are made. For medical use, and for convenient pharmaceutical employment, it requires to be levigated, when it constitutes the following preparation.

Prepared Sulphuret of Antimony. This is merely the preceding preparation reduced to an impalpable powder, by levigation and elutriation. It is in the form of a dull black powder, without taste or smell, and having a general resemblance to powdered charcoal.

Kermes Mineral. The true kermes is not officinal in the British or United States Pharmacopœias; but is embraced in the French Codex. This work directs it to be prepared by the following process, which is essentially that of Cluzel:—Take 1280 parts of rain-water, and having boiled it to free it from air, dissolve in it 128 parts of carbonate of soda. Boil the solution for half an hour, stirring it with a wooden spatula, and mixing with it 6 parts of sulphuret of antimony in very fine powder. Filter the liquor into a vessel containing warm water, previously freed from air by boiling. The liquor, as it falls into the water, deposits a dark-red powder. After it has cooled, decant the water and spread the powder on a thick cloth, and wash it with boiled water, first cold and afterwards hot, until the washings come off tasteless. Then submit the powder to the action of a press to expel the water, dry it in the shade, and preserve it in a bottle, secluded from the light.

Kermes mineral may be prepared in a similar manner, substituting carbonate of potassa for carbonate of soda; but the product, when the former alkali is used, being less smooth as a powder and less uniform in composition, is less esteemed.

Kermes mineral is in the form of a powder of a dark-brown colour, becoming lighter by exposure to the air. It is completely decomposed by muriatic acid with the assistance of heat, sulphuretted hydrogen being disengaged. Gay-Lussac considers it as a compound of sulphuret of antimony, with a small portion of protoxide, and rests his opinion on the facts, that tartaric acid will extract this oxide from ordinary kermes, and that the pure sulphuret (obtained by precipitating tartar emetic by sulphuretted hydrogen) is of

quite a different colour; but BERZELIUS contends, that tartaric acid will have this effect, only when the kermes contains a combination of protoxide with potassa (hypantimonite of potassa) which is not essential to its constitution. The only difference which BERZELIUS recognizes to exist between the true sulphuret and kermes, is that the latter always contains a small portion of sulphuret of potassium, which, not being removable by washing, must be deemed essential to its composition as a medicine, though not as a chemical compound.

Golden Sulphur of Antimony. This, strictly speaking, is not officinal in the British or United States Pharmacopœias, the precipitated sulphuret of these works being somewhat different. The Paris Codex directs it to be prepared by adding *acetic acid* to the liquor from which the kermes has been deposited. A new precipitate is thus formed, of a golden-yellow colour, which is the golden sulphur. It may be precipitated also from the same liquor by means of dilute sulphuric acid. Its composition is not well made out; but it may be gathered from the remarks of BERZELIUS, that he considers it proportional to antimonious acid; in other words, a *deutosulphuret of antimony.*

Precipitated Sulphuret of Antimony. This preparation is directed to be formed, in the British and United States Pharmacopœias, by substantially the same process, which consists merely in dissolving finely powdered sulphuret of antimony in a boiling solution of caustic potassa, filtering, and precipitating the filtered liquor by dilute sulphuric acid. The hot alkaline solution of the sulphuret, if simply allowed to cool, would deposit the kermes; and if the cold, clear, liquor were treated separately with dilute sulphuric acid, the golden sulphur would be precipitated. But, in the process above given as that of the Pharmacopœias, the causes productive of the distinct precipitates act simultaneously; and hence this formula will produce a product, which may be considered as a mixture of the kermes and golden sulphur. Admitting this explanation of its mode of formation, it must be viewed as an intermediate sulphuret.

Butter of Antimony. This is the sesquichloride of antimony, and is made, according to the French Codex, by distilling together, finely powdered and well mixed, 18 parts of very pure antimony, and 48 of corrosive sublimate. The chlorine combines with the antimony and distils over as a chloride, while the mercury, revived, is left in the retort. It may also be obtained by double decomposition, by distilling a mixture of sulphuret of antimony with corrosive sublimate. When procured by means of corrosive sublimate, it is perfectly free from water. At common temperatures, it is a crystalline mass; but when heated it becomes a soft solid, and afterwards runs like oil, properties which suggested its ancient name of butter of antimony. The same chloride may be obtained, but not entirely exempt from water, by distilling a mixture of one part of crocus of antimony and two of decrepitated common salt, with one of concentrated sulphuric acid. The antimonial oxide in the crocus, and the common salt, by mutual decomposition, form chloride of antimony, and soda, the latter of which, by uniting with the sulphuric acid, forms sulphate of soda. It may also be obtained by dissolving sulphuret of antimony in concentrated muriatic acid.

Butter of antimony is sometimes employed as a caustic by the surgeons; but its chief use is pharmaceutical, namely, to form the powder of Algaroth, described in the next paragraph.

Powder of Algaroth. This powder, so called from ALGAROTTI, the name of an Italian physician, who first recommended its use in medicine, is formed by the action of water on the sesquichloride of antimony. The Dublin process consists in first forming the sesquichloride by digesting sulphuret of antimony in muriatic acid, assisted by a small portion of nitric acid, and then pouring it into a large quantity of water. The water throws down a white flocculent precipitate, which is the preparation in question.

Powder of Algaroth is of a white colour. When exposed to heat, it melts, and on increasing the heat, with access of air, it rises in white vapours, condensing on contiguous cold substances. The nature of this powder is a subject of doubt. BERZELIUS considers it a submuriate, and states that when heated in a retort, a neutral muriate distils over, and protoxide of antimony remains behind. That it mainly consists of protoxide of antimony is proved by its applicability to the purpose of preparing tartar emetic, for the formation of which it is directed in the Dublin and United States Pharmacopœias. As a medicinal preparation, it has nearly gone out of use.

Diaphoretic Antimony. This antimonial is called the white oxide of antimony in the French Codex, and agreeably to the directions of that work, is prepared as

follows. Equal parts of antimony and nitrate of potassa, reduced to powder and well mixed, are deflagrated in a red-hot crucible. After the deflagration is over, the heat is increased for half an hour; and then the matter, having become semifluid, is thrown into water. A powder is precipitated which is to be washed repeatedly with water, until that liquid comes off tasteless.

In the above process, the antimony becomes oxidized to the maximum, that is, converted into antimonic acid at the expense of the nitric acid of the nitre, and in this state unites with the potassa. The mass, therefore, after the deflagration is over, is the antimoniate of potassa. The product as thus obtained constitutes the *unwashed* diaphoretic antimony of old pharmacy. By the action of water, as prescribed in the Codex formula, much of the potassa, and a certain portion of the antimonic acid are removed, leaving a white matter, consisting of antimonic acid united with about a fifth of its weight of potassa, which constitutes the diaphoretic antimony of the Codex, but which is commonly known by the name of *washed* diaphoretic antimony. If nitric or acetic acid be added to the waters employed in washing the above preparation, the potassa present is neutralized, and a white precipitate of hydrated antimonic acid is immediately thrown down, which was formerly called the *perlated matter of Kerkringius.*

Diaphoretic antimony is used in the Codex to form two officinal preparations; the *pulvis Cornachini* (Earl of Warwick's powder) and the *pilulæ adversus scrofulas.* The former is a mixture, in equal parts, of scammony, cream of tartar, and diaphoretic antimony; the latter contains the same antimonial, associated principally with scammony and ethiops mineral, (black sulphuret of mercury).

Glass of Antimony. (Vitrified Sulphuretted Oxide of Antimony.) This compound is prepared from the sulphuret by a partial roasting and subsequent fusion, conducted in the following manner:—The sulphuret is reduced to a coarse powder, and strewed upon a shallow, unglazed, earthen dish, and then heated gently and slowly, being continually stirred to prevent it from running into lumps. White vapours of sulphurous acid arise; and when they cease, the heat is cautiously increased to reproduce them. In this manner, the roasting is continued, until, at a red heat, no more vapours are found to arise. The matter is then melted in a crucible by means of an intense heat, until it assumes the appearance of melted glass, when it is poured out on a heated brass plate. It here congeals in a thin cake, which is afterwards broken up into pieces of convenient size.

In this process, part of the sulphuret is decomposed; its sulphur being driven off, while the antimony is converted into protoxide. The roasted matter, accordingly, consists of the portion of sulphuret undecomposed, and protoxide of antimony; and these, by uniting during the fusion, form the glass.

Glass of antimony is in thin, hard, and brittle pieces, exhibiting a vitreous fracture, and having a steel-gray colour. When well prepared, a fragment of it, held between the eye and the light, appears of a rich orange-red, or garnet colour. It is insoluble in water, but soluble, with the exception of a few red flocculi, in acids and cream of tartar.

The essential constituents of glass of antimony are the protoxide and sulphuret, united and vitrified by fusion. When of good quality, it consists of about eight parts of protoxide to one of sulphuret, and is almost entirely soluble in strong muriatic acid. As usually prepared, it contains about five per cent. of silica, and three of peroxide of iron. An excess of silica is indicated, when muriatic acid leaves a gelatinous residuum; and iron may be detected by ferrocyanate of potassa.

When glass of antimony is levigated and mixed with one-eighth of its weight of melted yellow wax, and the mixture roasted over a slow fire, with constant stirring, until it ceases to exhale vapours, a coal-like, pulverizable mass is formed, which is the *cerated glass of antimony,* a preparation formerly included in the Edinburgh Pharmacopœia.

Crocus of Antimony. This preparation is called in the French Codex, the *Semi-vitrified sulphuretted oxide of antimony.* It is usually made by deflagrating, in a red-hot crucible, equal weights of sulphuret of antimony and nitrate of potassa. The nitric acid is decomposed, and by furnishing oxygen to part of the sulphuret, converts its constituents into sulphuric acid and protoxide of antimony. The sulphuric acid then combines with the potassa, forming a white crust of sulphate of potassa above; while the protoxide unites by fusion with the undecomposed sulphuret, to constitute the crocus beneath.

Crocus of antimony is in the form of a liver-brown, opake, vitrified mass. When of bad quality, it is steel-gray. It consists, like the glass, of protoxide and sulphuret,

but united in different proportions, which are stated by Proust to be three parts of the former to one of the latter.

Subsulphate of Antimony. This salt was brought into notice as a pharmaceutical preparation of antimony, by Mr. Phillips, of London, who proposed it as an eligible substance for forming tartar emetic. It is prepared by boiling to dryness, in an iron vessel, powdered metallic antimony with twice its weight of sulphuric acid, and washing the grayish product with water, until the uncombined sulphuric acid is separated. This substance, though called a subsulphate, is essentially the protoxide of antimony, the quantity of acid which it contains being variable in amount and probably not constituting a definite proportion.

Tartar Emetic. This important double salt is the chief of the antimonial preparations, and as such deserves to be treated of fully in its pharmaceutical relations. The principle of its formation is exceedingly simple, being merely the saturation of the excess of acid in cream of tartar with protoxide of antimony. The various processes, recommended for its formation, all agree in boiling, in water, a mixture of cream of tartar with some form of antimonial protoxide, and only differ in the one selected, and in some minor details of manipulation. The United States Pharmacopœia, following the Dublin, employs the powder of Algaroth (nitro-muriatic oxide), the London, the glass of antimony, and the Edinburgh, the crocus. The French Codex gives two formulæ for preparing this antimonial, the glass being used in one, the subsulphate, agreeably to Mr. Phillips's recommendation, in the other. The proportions usually employed are equal weights of the antimonial oxide and cream of tartar, boiled with from four to six times their weight of water for about half an hour; but in the case of the nitro-muriatic oxide, this being a purer oxide than the others, four parts of it are sufficient for five of the cream of tartar.

In judging of the relative eligibility of the different forms of antimonial oxide, used in manufacturing tartar emetic, several circumstances must be taken into view. The glass of antimony, though capable of furnishing good tartar emetic, is objectionable on several grounds. Besides being liable to adulteration with glass of lead, it always contains about five per cent. of silica, and a small portion of peroxide of iron. Even when obtained of good quality, it requires to be finely levigated; as otherwise it will unite in part only with the cream of tartar. The same general objections lie also against the crocus. Rejecting the glass and crocus for the reasons above stated, Mr. Phillips proposed the subsulphate, which certainly furnishes an excellent and cheap material for forming tartar emetic. M. Henry, however, an eminent pharmaceutist of Paris, objects to the subsulphate, as being of variable quality; and, after an elaborate comparison of the different processes, gives a decided preference to the nitro-muriatic oxide (powder of Algaroth) of the Dublin College for preparing this antimonial. The only objection which has been urged against this oxide is its comparative cost, which is altogether a minor consideration, where the purity of so important a medicine as tartar emetic is concerned.

In preparing tartar emetic, it is desirable to have a slight excess of antimonial oxide, rather than an excess of cream of tartar; for in the latter case, the cream of tartar may crystallize upon cooling with the tartar emetic, and thus render it impure. In all cases, the antimonial should be obtained in well-defined crystals, unmixed with those of cream of tartar, as the best index of its purity; and apothecaries should purchase it in crystals, and as it is wanted powder it for themselves. The practice of some manufacturing chemists, of boiling the filtered liquor which contains the tartar emetic to dryness, whereby it becomes contaminated with the impurities which, in the crystallizing process, would remain in the mother waters, is very reprehensible, and should be entirely laid aside.

Tartar emetic, called correctly the tartrate of antimony and potassa in the Dublin and United States Pharmacopœias, is a colourless, inodorous salt, possessing a nauseous styptic taste, and crystallizing usually in rhombic octohedrons. When prepared by means of the nitro-muriatic oxide, its crystals have the appearance of tetrahedrons. As it occurs in the shops, it is in the form of a white powder, formed by the pulverization of the crystals. The crystals, when exposed to the air, effloresce slightly and become opake. Tartar emetic is insoluble in alcohol, but dissolves in fourteen times its weight of cold, and about twice its weight of boiling water. Its aqueous solution reddens litmus, and undergoes spontaneous decomposition by keeping. According to Berzelius, the protoxide is precipitated from the solution of this salt by sulphuric, nitric, or muriatic acid, but not by the alkalies. Agreeably to Turner, a little pure potassa throws

down the protoxide from a solution of tartar emetic, but takes it up again, if added in excess. According to the same authority, the alkaline carbonates throw down the protoxide also, but much more completely. TURNER also admits that the mineral acids throw down a precipitate; but instead of considering it, with BERZELIUS, the protoxide, he states it to consist of cream of tartar and a subsalt of antimony. It must be recollected, however, that on trying any of these precipitations, the solution of the antimonial salt must be strong, and the several precipitants not added too freely, otherwise they will produce no effect.

Tartar emetic is precipitated in a very characteristic manner by sulphuretted hydrogen, which throws down an orange-red precipitate consisting of hydrated sesquisulphuret of antimony.

When tartar emetic is pure, it should exhibit its appropriate crystalline appearance, and be entirely soluble in distilled water. Its solution should not be precipitated by muriate of baryta, oxalate of ammonia, acidulous nitrate of silver, or acidulous acetate of lead. A precipitate by the first reagent indicates sulphuric acid; by the second, lime; by the third, muriatic acid; and by the fourth, cream of tartar. The most usual impurities which it contains, are uncombined cream of tartar, tartrate of lime, silica and iron, and sulphate of lime. Cream of tartar is present, usually either from its having been used in excess in preparing the salt, or from fraudulent admixture. Tartrate of lime is derived from the cream of tartar, which always contains this impurity, as found in the shops. It is apt to form on the surface of the crystals of tartar emetic in crystalline tufts, which are easily brushed off. Silica and iron are liable to be present when glass of antimony has been employed in preparing the antimonial salt, and the evaporation has been carried too far. Sulphate of lime is sometimes an impurity, when tartar emetic has been prepared by means of the subsulphate. According to SERULLAS, tartar emetic, as ordinarily prepared, and all the other antimonial preparations, usually contain a minute portion of arsenic, derived from the native sulphuret of antimony, which almost always contains this dangerous metal. Its presence in tartar emetic may be detected by exposing the salt to the action of the blowpipe, when the peculiar odour of the arsenic will be perceived. This dangerous impurity, however, is not present in well-crystallized tartar emetic, a fact, which should form a strong additional motive with the apothecary, always to purchase this antimonial in crystals.

Besides being decomposed by the mineral acids, the alkalies whether pure or carbonated, sulphuretted hydrogen, and hydrosulphates, the same effect is produced by many other substances. Thus, it is decomposed by some of the metals and their oxides, by lime-water and muriate of lime, and by the acetate and subacetate of lead. This antimonial salt is also affected by common water when holding carbonate of lime in solution, but not when containing muriates, sulphate of lime, or extractive matter. Hence it is necessary to dissolve it in distilled water, when the pure effects of the medicine are designed to be produced. Other substances which decompose tartar emetic, are the decoction of tamarinds, lemonade, whey, and generally all bitter and astringent vegetables, such as Peruvian bark, rhubarb, galls, catechu, &c. Of these different substances, some precipitate the antimonial oxide, and others produce new salts with it, either soluble or nearly insoluble; but it by no means follows that they render the tartar emetic inert. On the contrary, the ordinary effects of the medicine are produced, though by the agency of the new combinations formed. Some doubt, however, may be entertained whether this remark will apply to the effects of the bitter and astringent vegetable medicines, which owe their power of decomposing tartar emetic to the presence of tannin, which forms an insoluble compound with the oxide of antimony. Nevertheless, LAENNEC has remarked that, though cinchona and infusions of other vegetables precipitate tartar emetic, still the new compounds formed have the same properties as those of the tartar emetic itself. It is difficult to believe this statement without some qualification; as the evidence is very strong in proof of the influence of bark and other astringent vegetables, in mitigating the effects of an over-dose of tartar emetic. The truth probably is that the tannate of antimony, produced by these vegetables, is not inert, though by no means so active as the undecomposed salt; and that it is capable of producing similar effects with tartar emetic, provided it be given in a sufficient dose.

Tartar emetic enters into but three officinal preparations, contained in the British and United States Pharmacopœias. These are antimonial wine, tartar emetic ointment, and Coxe's hive syrup (Mel Scillæ Compositum. Ph. U. S.).

Antimonial Wine is made by dissolving tartar emetic, in the proportion of two grains to the fluidounce, in Teneriffe or Sherry wine, or in a mixture consisting of four-fifths water, and one-fifth rectified spirit. The Edinburgh and United States Pharmacopœias use wine as the menstruum; the London and Dublin, water and spirit in the proportion above mentioned; but while the menstruum thus differs, the strength of the preparation, according to the different formulæ, is virtually the same. To make this preparation of good quality, the wine should be sound, and free from astringent principles, and the tartar emetic crystallized. Antimonial wine produces precisely the same effects on the system as tartar emetic; yet its use is convenient by affording a ready means of administering this antimonial in minute doses.

Tartar Emetic Ointment is made, according to the Dublin formula, by rubbing up a drachm of *very finely* powdered tartar emetic with an ounce of lard. It is not ordered by the other British Colleges, nor in the United States Pharmacopœia. This ointment, however, is generally made of twice the strength directed by the Dublin College. That recommended by the late Dr. Jenner consisted of spermaceti ointment nine drachms, tartar emetic two drachms, white sugar a drachm, cinnabar five grains, well rubbed up together. The object of the sugar, according to Dr. Paris, is to prevent the ointment from becoming rancid; of the cinnabar to give it colour, in order to prevent its being mistaken for simple ointment, which, without this addition, it resembles in appearance. The best unctuous matter which can be employed in making the ointment is lard, when the preparation is to be used in frictions; but when bound on a part spread on linen, it requires to have more consistence, and must be made of simple cerate, or spermaceti ointment. In all cases, the tartar emetic should be reduced to an impalpable powder, and thoroughly incorporated with the unctuous vehicle, which must be free from watery particles, as these have the effect of dissolving the tartar emetic, and of subsiding with it in solution. The therapeutic effects of this preparation will be noticed under a subsequent head.

Hive Syrup is a preparation having honey for its basis, and embracing the virtues of seneka, squill, and tartar emetic, of which latter it contains a grain to the fluidounce. (See *Hive Syrup*.)

Tartar emetic, adopting the results of Wallquist, may be considered to consist of two equivalents of tartaric acid $66 \times 2 = 132$, two of protoxide of antimony $76.6 \times 2 = 153.2$, one of potassa 48, and two of water $9 \times 2 = 18$; total 351.2.

Antimonial Powder. This preparation is usually made by roasting, in a shallow iron pot heated to redness, a mixture, constantly stirred, of equal parts of sulphuret of antimony in coarse powder, and hartshorn shavings, until it becomes of an ash-gray colour. By this treatment, the sulphur of the sulphuret is expelled, and the antimony oxidized; while the hartshorn, which is of the nature of bone, has the greater part of its animal matter consumed, and is reduced nearly to the state of phosphate of lime (bone-earth). The matter obtained by the roasting is reduced to powder, and put into a coated crucible, over which another is luted, with a hole in the bottom. It is then heated to whiteness, and kept at that temperature for two hours. The matter found in the crucible, after being finely pulverized, is the antimonial powder. By the calcination at a white heat, the remainder of the animal matter of the horn is dissipated; so that nothing remains but the phosphate of lime mixed with oxidized antimony. The degree of oxidation which the antimony attains, when the above process (the Edinburgh) is followed, is probably, from the white heat employed, that of deutoxide (antimonious acid); but it is certain that in different samples of antimonial powder, as found in the shops, a little protoxide is also usually present. This fact, as well as the variable action of antimonial powder on the system, warrants the statement that it contains antimony in a state of oxidation not uniform, associated with the phosphate of lime. In preparing this powder, the London and Dublin Colleges also employ a white heat; but these Colleges use a double proportion of hartshorn shavings. The use of the larger proportion of shavings will undoubtedly form a weaker preparation, but is justified on the ground of preventing the vitrification of a part of the antimony. The late Dr. Duncan, however, was of opinion, that the medicine did not correspond so nearly with Dr. James's powder, as analyzed by Dr. Pearson, when the larger proportion of the shavings was employed. He was on that account in favour of the Edinburgh proportions, which may be the more relied on, as they are those adopted in the French Codex.

Antimonial powder has a dull-white colour, is tasteless and inodorous, and insoluble in water. It is only partially soluble

in acids; the phosphate of lime, and any protoxide of antimony being dissolved, and a variable amount of antimonious acid left behind. Its activity as a medicine depends upon the proportion of protoxide present, which may be judged of by dissolving the preparation in muriatic acid, and dropping the solution obtained in water, whereupon the protoxide will be precipitated. Its composition varies very much, as already stated. Mr. PHILLIPS found two specimens, on analysis, to contain severally 35 and 38 per cent. of oxidized antimony; and Mr. BRANDE detected in one specimen, 5 per cent. of protoxide. Now the genuine JAMES's powder, as analyzed both by Dr. PEARSON and Mr. PHILLIPS, contained from 56 to 57 per cent. of oxidized antimony. A portion of this powder, derived from the heirs of Dr. JAMES, was found by BERZELIUS to contain nearly two-thirds antimonious acid (deutoxide), and one-third phosphate of lime, with scarcely one per cent. of antimonite of lime soluble in water. PHILLIPS and BRANDE speak of the antimony as being in the state of *peroxide* (antimonic acid); but it certainly must be in the state of *deutoxide* (antimonious acid), as stated by BERZELIUS, if the materials for forming the powder are exposed to a *white* heat, as directed by the British Colleges. From the above facts it must be evident that the antimonial powder of the shops is a preparation of variable composition; and it will be readily admitted that the Medical Convention for revising our National Pharmacopœia acted wisely in expunging it from that work.

§ III. EFFECTS ON THE SYSTEM, AND THERAPEUTICAL APPLICATIONS. The preparations of antimony were introduced into medicine towards the close of the fifteenth century; and the first treatise of importance written on them was the Currus Triumphalis Antimonii of BASIL VALENTINE. Their introduction gave rise to a keen controversy between the Galenists who denounced, and the chemical physicians who advocated, their use; and the former carried their opposition to such an extent, as to prevail on the Supreme Council of Paris to issue an edict in 1566 forbidding their use. By a revolution of opinion, not uncommon in similar cases, antimony was admitted, by the Paris faculty, into the *Antidotarium*, published in 1637. It was still, however, strenuously opposed by a number of physicians of Paris, and especially by GUY PATIN, who published a long list of unsuccessful cases, treated by antimony, under the title of *Martyrologe de l'Antimoine.* Finally, in 1666 the Parisian faculty met to decide the dispute, and determined in favour of the antimonial remedies, a verdict confirmed soon after by a decree of the Parliament of Paris, authorizing their use. The grounds of objection to antimony by its opponents were its poisonous qualities; grounds which would be taken as proof, in modern times, of its activity, and, therefore, remediate capabilities.

The antimonial preparations impress a special modification on the vital movements, which varies with their dose and manner of administration, and the condition of the system to which they are applied. In minute doses, they produce, in the mode of vitality of parts, those gradual changes, which, for want of a better term, are called alterative; and as their quantity is gradually increased, they are capable of occasioning successively a sedative, diaphoretic, cathartic, emetic, contro-stimulant, and corrosive effect. Where effects so diversified are produced by the same class of remedies, it is not easy to reduce their modus operandi to general principles. It may be admitted, however, that the antimonials have the power of producing a disturbance in the vital actions, whether healthy or diseased; and that this disturbance is manifested thus variously, not only according to the dose and the condition of the system, but also according to the degree of solubility of the particular preparation, its power as a local irritant, the extent of its dilution if soluble, and the amount in which it may be absorbed. If the antimonial be given in a minute dose, especially if soluble, and exhibited very much diluted, its action is that of an *alterative.* If administered in somewhat larger doses, it produces, without creating nausea, a sedative effect throughout the whole system, but especially upon the heart and arteries. The remedy, in a somewhat increased dose, causes nausea, which may be viewed as the first indication of a vital resistance, on the part of the stomach, to the entrance of a noxious agent, by way of absorption, into the blood. At the same time, part of the antimonial may still be absorbed, with, perhaps, increased sedative effects, evinced more particularly by relaxation of the exhalants of the skin. If the antimonial be continued in nauseating doses, it may not act powerfully enough to produce emesis; and yet, by stimulating the absorbents of the stomach and bowels which now refuse to let it pass by absorption, may cause these to pour out their contents, and thus

produce a cathartic effect. A larger dose of the antimonial causes vomiting, probably by still further arousing the vital resistance of the stomach. Finally, if given in a poisonous dose, especially if the preparation be chemically acrid, or soluble and undilute, it may be conceived to paralyze the vital actions of the stomach, and, consequently, to be neither absorbed nor expelled. At the same time, the nervous system would receive so great a shock, as to cause a general depression of the vital powers, similar in nature to that produced by small doses of antimony, but far greater in degree, and attended with lesion of the stomach.

The view here taken of the modus operandi of antimonials in producing vomiting may be objected to on the ground, that wherever applied in a proper dose they have a strong tendency to excite emesis. Thus when injected into the rectum or veins, or applied to any surface by which they may be sufficiently absorbed, they produce vomiting, just as when they are brought in contact with the stomach; a fact which shows that the emesis is not exclusively the effect of the local irritation on the mucous surface of the stomach.

The antimonials as a class have generally been characterized as irritants; but in a practical point of view, they should not all be deemed such. In one sense, every substance that can make an impression on the system, may be called an irritant; but taking the word in its ordinary acceptation as a pathological term, it includes every agent capable of producing inflammation or increased action in a part. Admitting this definition of an irritant, minute or small doses of antimony, when they excite neither nausea nor uneasiness of stomach, cannot be classed as such. On the other hand, when the metal is given in larger doses, especially if one of the soluble preparations is employed, which are uniformly most active, its irritant effects will be manifested. The solubility or non-solubility of the preparation, and its degree of dilution if soluble, are circumstances which must be taken into the account. If insoluble in water, its irritating effects, cæteris paribus, will be less or longer in being developed; if soluble, the same dose may act as an irritant when given in substance, and as a sedative when largely diluted. Thus half a grain of tartar emetic, if given in pill, may, by coming in contact with the stomach, in its solid state, act as an irritant; while if given at once dissolved in a pint of water, it would have no such effect. Many analogies support this view of the influence of the dose and concentration of a remedy, in determining its physiological action. The mineral acids, concentrated, are corrosive poisons; largely diluted, refrigerant. Again, sugar of lead in substance, or in concentrated solution, is irritant; and in very weak solution, as lead-water, an abater of inflammation and irritation.

Abundant proof certainly exists, that the antimonials are capable of acting as irritants; but this by no means shows that they necessarily must be so in every dose, and under every form of administration. Thus, Rayer reports a fatal case of apoplexy, in which, during the five days the patient was sick, he took forty grains of tartar emetic, without producing nausea or vomiting. Upon opening the body, the alimentary canal exhibited changes, manifestly dependent on the action of the antimonial. The stomach was very red and inflamed, and filled with bile and mucosities. The inflammation appeared to be confined to the mucous membrane of this viscus, upon which were perceived irregular spots of a livid red colour, on a violaceous base. Here an antimonial proved to be irritant, having been given in large doses without the stomach responding to the impression in the usual way, in consequence of the lesion of the nervous system, implied by the apoplectic state; but it would be a vicious use of reason to conclude from this or similar facts, that tartar emetic, however exhibited, as in half or quarter grain doses daily in a quart of water, would prove irritant. On the contrary, it may be conceived that minute doses of a substance, irritant in medium or large doses, may act as an abater of irritation, by creating a new impression, inconsistent with the preceding one, in the irritated part. Holding these views, we conceive that the positions taken in the following quotation are altogether too general to be admitted as precise. "All the preparations of antimony, without exception, possess an irritant property. Thus tartar emetic applied to the skin, or to the mucous membrane of the eye, nose, mouth, or genitals, excites a severe and peculiar inflammation. Taken into the alimentary canal, it always causes an inflammation more or less intense, modified by the previous condition of the canal, and by some other circumstances difficult and often impossible to appreciate."

The error of supposing the antimonials to be necessarily and universally irritant,

is the more to be regretted, as it has a tendency to cause the practitioner to overlook, if not to deny, their sedative or antiphlogistic effect. This effect may be considered as belonging to small doses; and to such doses because they are more easily absorbed, and, by their presence in the circulating fluids, independently of any necessary connexion with evacuation, lessen the vital actions whether healthy or diseased, without producing those perturbations which larger doses would create. But, explain it as we may, still it is certain that antimony, properly administered, has a depressing influence upon nearly all the vital phenomena, and consequently may become proper in diseases characterized by excessive action. In most fevers, therefore, and in all inflammations, it may prove useful as an antiphlogistic remedy. Gastritis even is not an exception; for the principles here laid down, call only for the constitutional effects of the remedy; and it by no means follows that, in obtaining these effects, it must be brought in contact with the suffering organ. On the contrary, some other channel for its introduction would be proper. In fevers, the general effect of the antimonials is to reduce the force and frequency of the pulse, and at the same time to lessen the rapidity of the respirations, and the heat of the surface. In this class of diseases, the stomach is the seat of more or less irritation, but it by no means follows from this fact, that antimonials must be abandoned in their treatment. It is unquestionable, that antimony was formerly too freely given in fevers; for where nausea and gastric distress exist, as they often do, it seems hardly justifiable to aggravate these local conditions, in order to gain its depressing influence on the heart and arteries. On the other hand, however, it may be admitted that the prevalence of the gastric pathology of fever has led some practitioners into the opposite extreme, and caused them to proscribe antimonials in that class of diseases altogether. Upon the whole, it may be averred, that the antimonials constitute a valuable resource in the treatment of febrile diseases, and may be so managed, in many instances, as to do incomparably more good by their depressing influence on the actions of the general system, than harm by any local irritation, supposing such necessarily to take place.

The general antifebrile and antiphlogistic action of the antimonials, when given in small doses, having been sufficiently set forth in the preceding remarks, it may now be proper to descend into details, and to speak of the more prominent effects of these preparations, on the different systems, functions, and tissues of the body.

Circulatory System. MM. Recamier and Trousseau, who appear to have accurately studied the effects of antimony on this system, by means of observations made on a great number of patients at the Hôtel-Dieu, found, by its use, that the pulse became weak and slow, and that the pulsations of the heart, explored by the stethoscope, were in harmony with the pulse. They observed, in some cases, the pulsations to descend in three days from seventy-two to forty-four in a minute, and to remain for a long time at that number. Ordinarily the pulse was reduced in force in a very marked manner; but the number of pulsations did not descend lower than a fifth or a fourth. They observed sometimes that the pulse became excessively irregular, without losing its frequency; and this irregularity lasted sometimes during the whole period of the medication, but more generally it preceded and announced the diminution of the frequency of the pulse.

Cutaneous Exhalants. A very common effect of the antimonials, and generally a concomitant one with that on the circulation, is an impression made on the cutaneous exhalants, in consequence of which the insensible perspiration is increased, and the skin, from being harsh and dry, becomes soft and moist. This effect takes place more invariably when nausea has been produced, and perhaps to a greater extent; but this sensation is by no means essential to its production. On the contrary, the antifebrile and diaphoretic influence of antimony may be produced in a most decided manner, without creating the least nausea. While this is admitted, it by no means follows, as is supposed by some writers, that the occurrence of nausea is unfavourable to obtaining the specific antifebrile effects of antimony.

Respiration. Recamier and Trousseau found that the number of respirations was diminished to such an extent, as sometimes to be reduced from sixteen, twenty, or twenty-four, to six in a minute. The patients, breathing with this extreme slowness, did not experience any difficulty in respiration; on the contrary, they gave evidence by their countenance, and by their declarations, that they felt better. The effects of antimony on the circulation and respiration were often found by the above-mentioned writers to continue for

several days after the medicine was discontinued.

Pulmonary Mucous Tissue. Minute doses of the antimonials frequently cause the pulmonary exhalants to discharge an increased quantity of matter, and of a more liquid kind, and hence act advantageously in many diseases as an expectorant. The theory of their operation is not important; but it may be supposed to be by lessening action in the pulmonary mucous vessels, which, in the cases benefited by the remedy, are too highly excited to secrete freely. Where the action of these vessels is too weak, as in the last stages of pulmonary consumption, antimonials, as expectorants, are contra-indicated, and carbonate of ammonia, by its stimulating effects, may prove useful.

Urinary Secretion. According to Recamier and Trousseau, the use of antimonials almost always augments the secretion of the urine. This effect has not been generally mentioned by writers; and when it does take place, it will probably be in cases, in which the diaphoretic effect of the remedy is prevented by the application of cold to the surface, or by some other cause.

Lymphatic System. That antimony is capable, under peculiar circumstances, of throwing the brunt of its action on the lymphatics, is proved by the fact of its having, in a few rare instances, produced ptyalism. The late Dr. James stated that he had seen six instances of this kind; but in them, the teeth were not loosened, nor was the breath rendered offensive as in mercurial salivation. That there is a slight affinity between antimony and the salivary glands is made probable by the fact that the system is rendered more susceptible of the influence of mercury, by combining it with antimonial preparations. Dr. Eberle plausibly explains this fact, by referring it to the power which nauseating doses of antimony possess of favouring an afflux to the salivary glands. This idea is ridiculed by Dr. Paris, in a note to his Pharmacologia, which has no other merit than that of being witty. He says that if Dr. Eberle's explanation were correct, no one need despair of influencing his patient by mercury; since nothing more would be necessary than to condemn him to meagre fare, and then to tantalize him with the sight or smell of a savoury dish!

The diversified effects produced by the antimonials, whether alterative, sedative, cathartic, emetic, &c., so far as dependent on the dose, have been sufficiently dwelt upon in the foregoing remarks. But there are a number of other circumstances which modify their operation; such as the particular antimonial employed, the susceptibility of the alimentary canal, the duration of the medication, the diet and regimen directed, and the age and sex of the patient. These will next claim our attention.

Particular Antimonial. The antimonial preparations differ very much in activity, from tartar emetic, the most active, down to antimonious acid (deutoxide) which is nearly inert. The order of their activity in the descending scale is 1. tartar emetic; 2. perfectly pure and porphyrized metallic antimony; 3. unwashed diaphoretic antimony; 4. kermes mineral; 5. powder of Algaroth; 6. washed diaphoretic antimony; 7. pure protoxide; 8. antimonious acid. Trousseau places antimonic acid (peroxide) last, as the least active of all the preparations; but this is probably a mistake, arising from the circumstance that the real antimonious acid has generally been called, in medical works, the peroxide. It admits of much doubt, indeed, whether the therapeutic effects of the pure peroxide have as yet been tried. Of the above preparations, the more active, such as tartar emetic and porphyrized antimony, are capable of producing, by graduating the dose, all the effects of the antimonials, from the most active vomiting and purging, to their almost imperceptible alterative effects; while the less active preparations can be viewed as appropriate only for creating the sedative operation of the antimonials. Thus to produce an effect equivalent to that of half a grain of tartar emetic, it would be necessary to use five or ten grains of kermes mineral, from half a drachm to a drachm of the protoxide, and from two drachms to half an ounce of antimonious acid.

According to Trousseau, the choice of the antimonial is of the highest importance to the judicious employment of the antimonial preparations. A good summary of his views on this point is contained in the following quotation. "Antimony acts most frequently, not by an inflammation which it excites in the mucous membrane of the intestine, not by modifications produced in the secretions, but solely by an organic modification, the nature of which is unknown, and which is equally special with that produced by mercury, arsenic, opium, the solaneæ, the strichnos, &c. It, accordingly, follows, that, whenever it is absorbed, it produces its effects, whatever may be the form under which it is employed, in the same manner that opium produces narcotism, sweats, &c. under

every form in which it may be taken. The problem to be solved is, therefore, this: *to cause as much antimony to be absorbed as we can, and at the same time to cause the slightest possible local lesions;* and the administration of the oxides of antimony fulfil the conditions of the problem. I do not hesitate to declare that if the Rasorian method has met with so many opponents, its disfavour is to be attributed, less to the inutility and danger of antimony, than to the bad choice of the antimonial compound; and if, on the one hand, I admit that tartar emetic in large doses is often a dangerous agent, I assert on the other, resting my assertion on experience, that the oxides of antimony have, in the cases referred to, all the advantages of tartar emetic, without its inconvenience." (Trousseau. Art. *Antimony, in Dict. de Méd.* III. 225.)

The views of Trousseau expressed in the above extract, may be admitted to be correct, so far as they assert that the constitutional effects of antimony are obtained, in proportion as the remedy is absorbed without producing local lesions. But it by no means follows, that the mode of using antimony by Rasori, (tartar emetic in large doses,) is a case in point; for though the tartar emetic, when used in these doses, may, to a certain extent, be absorbed, it probably acts on a principle totally different from absorption.

Susceptibility of the Alimentary Canal. When inflammation exists in the mucous membrane of the alimentary canal, doses of antimonials, which under other circumstances would be absorbed either in whole or in part, and produce an antiphlogistic effect on the general system, will now exasperate the inflammation, fail to be absorbed, and consequently produce repeated vomitings and purgings. Trousseau declares that he has seen phthisical patients perish rapidly from the administration of antimonials, which acted by aggravating the tuberculous inflammation of the intestines. It is certain that antimonials must be used with great caution, and their effects closely watched, when the state of the alimentary canal is a matter of doubt; but it is going too far to assert, as Trousseau has done, that antimony can be given only in cases in which the alimentary mucous membrane is healthy. The adoption of such a rule would exclude antimonial remedies in many inflammatory diseases, in which this membrane is to a certain extent affected. The proper rule, in such cases, lies between the extremes;—neither to abandon the antimonials altogether, nor yet to use them with an unsparing hand. When the irritation is not intense, antimony may be used in minute doses, with the well-founded expectation of its being absorbed, so as to produce its antiphlogistic influence; while its local action would be inappreciable, or if slightly irritant, less injurious as such, than beneficial by controlling general action.

Trousseau appears to admit in practice, the principles here insisted upon, and perhaps to push them further than we do. Thus he remarks that it must not be supposed that the existence of an abundant acute diarrhœa, and of vomiting, will always contra-indicate the use of antimonials, and appeals to the results of Laennec to show that such a condition of the abdominal viscera is often relieved by a large dose of tartar emetic or kermes. But it may be asked, is the mucous membrane healthy in such cases, as Trousseau says it must be to justify the use of antimonials? We admit, however, that the practice might be useful in diarrhœas and vomitings of a certain kind, for example, when they are bilious; for here the remedy would speedily remove the offensive matters, more irritant to the system than the remedy itself. Still even in the case supposed, we should prefer ipecacuanha as an evacuant, unless the condition of the system was such as to call for a vigorous agitation of the abdominal viscera, particularly the liver.

In deciding on the extent to which antimonials may be used when the alimentary canal is more or less implicated, the practitioner should consider whether this part is primarily or secondarily affected. If primarily affected, he should abstain from the use of these remedies, or try them with the greatest caution; but if, on the other hand, the affection of the alimentary canal is secondary to an inflammatory affection of some other part, antimonials as a general rule may be employed. Thus in acute pneumonia, antimony may be often given with great advantage, even though the stomach and bowels are the seat of a secondary affection; but when the contrary takes place, and inflammation of the lungs supervenes on bowel disease, the antimonials aggravate the primary affection, without benefiting proportionably the secondary one. Thus Trousseau declares that he has often seen Laennec, for want of making these distinctions, produce a fatal aggravation of that form of intestinal disease, called dothinentery, when it happened to be complicated with thoracic disease.

Duration of the Medication. It is a fact well ascertained by repeated observation, that the violent effects, such as vomiting, purging, colicky pains, &c., produced by the soluble preparations of antimony when first administered, generally subside after a shorter or longer interval, extending usually from twelve hours to three days; the system becoming in the mean time habituated to the remedy, which no longer produces the above-mentioned effects, but a depressing influence on the vital movements. This peculiar condition of the system, of bearing the remedy without its producing marked perturbations of the system, is called by Rasori, the condition of *tolerance* (see this word); and when it is brought about, *tolerance* is said to be established. To produce this tolerance of the antimonials in certain phlegmasial diseases is, according to this Italian physician, and to others who enter more or less into his views, of the utmost importance; and the physicians of this school seek to induce it by all the means in their power. According to Trousseau, its immediate production is almost always the consequence of using insoluble, instead of the soluble, antimonial preparations; as they enter the circulation readily, without producing, except in rare cases, either vomiting or diarrhœa. The results of this practice require to be amply confirmed, before it would be proper to rely on them implicitly; but should they prove well founded, they will enable the practitioner to avail himself fully of the antiphlogistic effects of antimony in large doses, without producing those local lesions which so frequently result from the use of tartar emetic and the other soluble preparations of this metal.

The duration of the tolerance, after having been established, is very variable; and it becomes important to know what circumstances may cut it short, or render it less liable to be terminated. When the tolerance is established with difficulty, it generally has but a short duration; but when readily induced, it lasts four, eight, and even fifteen days when the soluble preparations are employed, and almost indefinitely, when the insoluble ones are resorted to.

It becomes necessary, however, whatever may be the duration of the tolerance, to omit the antimonials as soon as it ceases. To attempt to continue them afterwards, would, according to Trousseau, give rise to the danger of producing lesions of the stomach. Accordingly, the occurrence of vomiting and purging, after tolerance has been established, shows that it is at an end, and that the antimony must be discontinued. On this point, the views of Rayer, the writer of the article Antimony in the *Dict. de Méd. et de Chir. Pratique*, are diametrically opposite. Thus he remarks that he has never known the good effects of tartar emetic to be more marked than when, on the access of peripneumonies, it has procured abundant evacuations upwards and downwards; a fact which tends to prove, according to him, that, contrary to the opinion of Rasori, the derivative action and depletive revulsion of tartar emetic on the stomach and bowels, are prominent elements in its curative effects. Dance and Chomel appear to be of the same opinion; for, according to them, antimony has no special mode of action. When it purges or vomits, it acts precisely like purges and emetics in general; and when it is perfectly tolerated, it is without effect. We can barely conceive of some cases of inflammations, other than of the alimentary canal, in which the evacuant qualities of the antimonials could replace advantageously their antiphlogistic effects consequent upon tolerance; but, as a general rule, the influence of the remedy obtained by tolerance is much more to be relied on.

Supposing the establishment of the tolerance of antimonials to be important in the treatment of certain inflammations; it becomes an interesting question to determine, how this state can be most certainly induced, or how reproduced, after it has ceased. Laennec was in the habit of promoting the tolerance of tartar emetic by associating it with opium, and of lessening its nauseating effects by the addition of aromatics. Trousseau objects to the use of opium for this purpose, except at the very beginning, on the two grounds that opium injures the antiphlogistic effects of antimony, and has a tendency for a time to mask intestinal lesions, which afterwards manifest themselves with great force.

It sometimes happens, when tartar emetic has been used for several days, that the patient experiences a sensation of tension in the throat, and over the lining membrane of the mouth, accompanied by some pain and a metallic taste. This condition of the mouth and throat has been assimilated to that produced by mercury, and has been expressed by the phrase, *antimonial saturation.* We agree, however, with Trousseau, in believing that the condition referred to is no indica-

tion of a constitutional impression from antimony, but is entirely local.

Diet and Regimen employed. As in the case of other remedies, the diet employed during the administration of antimony has an important influence on its effects. As a general rule, the more severe the diet, the more easy the establishment of tolerance, and the more prominent the constitutional effects. If aliment be incautiously given, its digestion is arrested, and the remedy, assisted by the distension caused by the food, gives rise to vomiting, whereby the antimony is discharged. We cannot admit, however, the accuracy of Trousseau's opinion, that "the local irritant action of the antimonials is so much the stronger, as the quantity of aliments is more considerable." Vomiting, under these circumstances, more readily takes place; but this does not prove a greater local irritant action on the part of the antimony, since its effect is assisted by extraneous causes. On the contrary, the remedy would prove less irritating from being mixed up with the alimentary matters, and from being quickly discharged; while its constitutional effects would be defeated by its non-absorption.

Certain aliments, such as wine, the acid fruits, and drinks made from acerb and acid fruits, augment in a remarkable manner the activity of the insoluble preparations of antimony. They act by the tartaric or citric acid which they contain, and which, by forming a soluble salt with the antimonial, renders it violently emetic. In the case of so soluble a salt as tartar emetic, it may be doubted whether the above-mentioned substances have any power of increasing its activity.

Age and Sex of the Patient. It has been established by observation, that vomiting and diarrhœa are more easily excited by antimonials in children and females, than in male adults; and at the same time, the tolerance of the remedy, as a general rule, endures a shorter time with the former than with the latter. The administration of antimonials to children should be most carefully watched; as their effects are sometimes inordinately disproportionate to the dose employed. It is on this account that antimonial wine should not be used as a domestic remedy; for from being given ignorantly, it has not unfrequently caused the death of children.

We have now finished the consideration of the more important circumstances, independently of dose, which modify the operation of the antimonial preparations. Many of these circumstances increase the effect of the remedy; and it is impossible, under all the varying effects of these preparations in different cases, to foresee the extent of their operation. It, therefore, sometimes happens, even to judicious practitioners, and not unfrequently to the bold and empirical, that antimony produces such grave disorders of the digestive functions, as to call for the immediate discontinuance of the remedy, and the adoption of curative measures to relieve the artificial disease. When the preparations, on their first employment in proper inflammatory cases, produce free vomiting and purging, these effects may be generally overlooked; as they are usually of short duration, and disappear in the course of a day or two, by which time tolerance is established. But if they should come on after the period of tolerance, their occurrence is then quite a serious matter. The measures to be adopted under these circumstances, besides the immediate omission of the antimony, are the use of an amylaceous diet, demulcent drinks, and anodynes. A convenient anodyne is furnished by the sulphate of morphia, which may be given in half-grain doses by the mouth, or in double that quantity by injection, every two hours, until the more urgent artificial symptoms have subsided. As soon as this object has been attained, Trousseau recommends the administration of six-grain doses, three or four times a day, of subnitrate of bismuth, as well calculated to remove all remains of functional disorder of the alimentary canal.

In the foregoing remarks we have presented a number of considerations on the diversified effects of the antimonials as a class, and on the different therapeutic precepts which are applicable to their administration. But every antimonial is supposed to possess some peculiar properties of its own, which cannot be arranged under the generalities belonging to the whole class, and which consequently require to be noticed under the head of each. This is emphatically true with regard to tartar emetic, which possesses, in some respects, peculiar properties, and is susceptible of many applications which belong to no other antimonial. In noticing the antimonials as therapeutic agents, individually, we shall begin with tartar emetic as the chief preparation, and treat of the rest in the order in which they are noticed under the pharmaceutical head.

Tartar Emetic. Syn. *Tartrate of antimony and potassa; Tartarized antimony; Stibiated tartar; Antimoniated tar-*

tar. The discovery of tartar emetic was made about the year 1638, and is attributed to Adrian Mynsicht. It was always considered the chief antimonial; and the controversies which were so long kept up respecting the antimonials, turned more particularly on the merits or demerits of this salt. At first, a large number of antimonial preparations were employed; but in the progress of time, many fell into neglect, so that during the eighteenth century, the prepared sulphuret, kermes mineral, diaphoretic antimony, the glass, antimonial powder, and tartar emetic were almost the only ones employed. In proportion to the progress of knowledge, the number of preparations in use has gradually diminished; so that at the present day, the kermes, antimonial powder, and tartar emetic may be considered as the chief antimonial remedies prescribed. Every day's experience, however, seems to diminish the use of the two former, and to increase that of the latter, showing that the evident tendency of medical opinion is to settle down upon tartar emetic as the best preparation of the class. Indeed, many distinguished practitioners entertain the opinion, that there is no therapeutical effect that can be gained by other antimonials, which cannot be equally well attained by tartar emetic. This assertion, without limitation, may not be true; but still in the great majority of cases of disease, where an antimonial would be proper, every indication can be fulfilled by the use of this salt. Besides, it has the advantage, when crystallized, of offering a composition which is always identical; except that it is subject to a trifling efflorescence, which slightly increases its activity under the same weight.

Like the antimonials generally, tartar emetic is capable of producing, according to the dose, and the state of the system, an alterative, sedative, diaphoretic, cathartic, emetic, contro-stimulant, and corrosive effect. It may be supposed also capable of giving rise to all these effects, by whatever channel it may be introduced, whether by the stomach, rectum, skin, or veins. It is indeed true, that particular channels are selected when particular effects are sought for; as the skin, when its corrosive effects are desired; but even by this channel, the sedative or emetic effect may be produced, by favouring the absorption of a diluted solution of the salt, in an appropriate dose, by the denuded cutis.

When tartar emetic is given in doses of from the thirty-second, to the sixteenth of a grain, largely diluted with water, repeated every hour or two, so as to administer from a quarter to half a grain daily, it may be continued for a long time without inconvenience to the patient, and acts as an alterative. In a dose somewhat greater (from the eighth to the sixth of a grain) it is capable of producing a general depression of the vital actions. In a still higher dose, varying from a grain to three or four grains, it may be made to be actively cathartic or emetic, or both. Increasing the dose still further, and managing the exhibition, by the smallness of the vehicle, by diet, &c., so as to produce a support or *tolerance* of the remedy, without vomiting or purging, or other obvious evacuation, so strong an impression is made upon the vitality of the stomach, the centre of so many irradiated actions, as to produce a general depression of the vital powers, on the principle, as we believe, of *revulsion*, but as Rasori would term it, of *contro-stimulus.* Finally, when applied to a part in the solid state, as for example the skin, it acts as a corrosive. Thus it is perceived, that according to the dose, state of dilution, condition of the system, and mode of exhibition, tartar emetic becomes a totally different, and sometimes even a diametrically opposite remedy.

Considering the diversified action of tartar emetic, according to the dose, dilution, &c., no sweeping conclusion can be drawn from its effects, when given in an over-dose, to inferior animals, in determining its character as a therapeutic agent. These effects are violently irritant; but this admission by no means proves that tartar emetic is necessarily irritant. Experiments made on inferior animals, in investigating the action of medicines, are certainly valuable; but there is reason to believe, from the mode in which they are conducted, that too hasty conclusions are sometimes drawn; and that those effects which belong to a substance under the special circumstances of its employment in an experiment, have been erroneously attributed to it universally. Accordingly the exhibition of large or poisonous doses of tartar emetic to animals, or the application of such doses to wounds or mucous surfaces, may enable us to decide on the lesions which such doses may produce, but throws no light, or rather obscures our reasoning, on the effects of minute or small doses of the same remedy. With these limitations as to the value of experiments such as we have alluded to, we shall proceed to notice the results of Magendie and others, obtained by that mode of investigation.

It results from the observations of MAGENDIE, 1. that tartar emetic, administered to middle-sized dogs, in doses of a drachm, rarely produces bad effects; 2. that the younger the animals, the more susceptible are they of the action of this substance; 3. that the duration of the vomitings and purgings is proportional to the nervous susceptibility of the animal; 4. that the salt is dangerous, only when it is not rejected; so that, the more free the vomiting, the less likely is it to produce deleterious effects; 5. that it is with tartar emetic as with gunpowder, the more concentrated, the more violent its action; 6. that in consequence of idiosyncrasy, the same dose may cause one animal to perish, and fail to produce death in another of the same age, and apparently of the same vigour; 7. that tartar emetic, injected into the veins, or brought in contact with absorbing surfaces, such as a loop of intestine, the cellular tissue, or the substance of the different organs, causes vomiting and purging, just as it does when introduced directly into the alimentary canal; that death takes place after a variable period, and that the bodies always present the same alterations; 8. that these consist of an inflammation, more or less extensive, of the mucous membrane of the alimentary canal, and blackish irregular spots in the lungs, extending more or less deeply into the substance of these organs; 9. and, lastly, when tartar emetic causes death, the effect is due rather to the absorption of the salt than to any direct action which it exercises on the stomach.

RAYER repeated the experiments of MAGENDIE, employing rabbits for the purpose instead of dogs. His results differ, in some respects, from those of MAGENDIE, and particularly in the *absence of all lesion of the lungs*, whether the animals were poisoned by half a drachm of the salt, introduced into the cellular tissue of the thighs, or by twenty-four grains, included by ligatures in a loop of intestine.

TROUSSEAU admits that tartar emetic exercises on the tissues to which it is applied an energetic irritant action; but adds that its local effect is singularly modified by several circumstances. Thus, if a grain of tartar emetic be placed on the eye, it produces a redness immediately, followed by violent inflammation. Intense inflammation is also produced, when the salt is brought in contact with the mucous membrane of the genitals, ear, nose, or mouth. On the skin it produces a pustular eruption, and on the mucous membrane of the alimentary canal, under certain circumstances, powerful irritation. Nevertheless this irritant action is not always manifested; and TROUSSEAU enters into an inquiry, why the irritant effects of tartar emetic are sometimes produced, and sometimes absent. In pursuing this inquiry, he justly remarks that the cases are totally distinct, where tartar emetic is concentrated and cannot be thrown off or displaced, as when applied to the skin or any accessible mucous surface; and where it is spread over a large surface and is constantly changing its position, as when passing through the alimentary canal. Thus he remarks, "where tartar emetic is swallowed, it produces less local effects; because, in the first place, it is in great part expelled by vomiting; in the second place, it passes rapidly through the track of the intestine, and consequently but small quantities are in contact with the same part; in the third place, the stools carry off the greater portion of that which is left; and, besides, the assimilating power of the digestive organs has a tendency to neutralize the irritant action of a certain quantity of the salt. Moreover, this digestive power may, under certain circumstances, be so strong, that enormous doses of tartar emetic, half an ounce for example, may be given many days in succession, without being followed by any appreciable disorder of the mucous membrane of the alimentary canal."

In support of the views here taken by TROUSSEAU, of the influence of modifying circumstances on the ordinary irritant action of tartar emetic in large doses, we may cite the post-mortem examinations of RAYER, in the few fatal cases of pneumonia which occurred under his care, after being treated by the Rasorian method. He did not find the stomach and intestines notably inflamed, except in one case, in which the mucous membrane of the stomach presented a rosy tint. In another case, in which but seven or eight grains of tartar emetic were used, the veins of this viscus were prominent, and distended with blood, which could be made to circulate by pressing them with the finger; a condition of the vessels which appeared to be owing to the difficulty of the circulation just before death; for the liver and spleen were gorged with blood. In all the cases, the mucous membrane had its natural consistence and thickness, and peeled off by means of the nail, in large layers, as it does in its healthy state. RAYER then adds, that all the patients who died, entered the hospital in the second or third stage of the disease, and, therefore, at a

period too late to allow of much tartar emetic to be taken. STRAMBIO relates that upon examining the bodies of many individuals who died of pneumonia after having been treated by RASORI, and who had taken from twelve grains to the enormous dose of half an ounce of tartar emetic, the stomach in some was interiorly covered with a red liquid resembling a syrup highly charged with kermes, and its mucous membrane presented a red appearance; while in others, no lesion either of the stomach or lungs could be detected, sufficient to explain the fatal termination. In these latter cases, STRAMBIO supposes, that death took place in consequence of the exhaustion of the vital forces, determined by the enormous doses of the antimonial; and this explanation must be admitted as correct, provided death occurred soon after their administration.

We shall now return from this digression as to the effects of large doses of tartar emetic on the system, and the lesions which they are capable of producing, to the examination, under separate heads, of the distinct therapeutic effects of tartar emetic, which constitute it, in each of those effects, virtually a distinct remedy.

a. *Tartar emetic as an alterative.* Employed in this manner by the use of very minute doses, it has been recommended by LANTHOIS of Montpellier, in incipient phthisis. His mode of exhibition was to dissolve a grain of tartar emetic in eight table spoonfuls of distilled water, and to add this solution to six or eight pints of water. This very dilute solution was used by the patient as his common drink, at meals, or at any other time, without limitation, its use being attended with no inconvenience. The way in which it acts is by lessening the force and frequency of the pulse, independently of any nauseating effect, and, perhaps, by removing structural disease, as a consequence of increasing the activity of the absorbents. Dr. EBERLE has used tartar emetic in the manner recommended by LANTHOIS, in several cases of phthisis, and with better effect than that derived from any other remedy which he had used in that disease. On the recommendation of a friend, we gave the same remedy in half-grain, and afterwards grain doses in the twenty-four hours, dissolved in a pint of water, in a case of disease threatening consumption, and attended with frequent pulse, and occasional spitting of blood. The remedy produced occasionally a little nausea, and was attended with a marked reduction of the pulse, and a general melioration of the symptoms. Tartar emetic may be given in the quantity of half a grain in the twenty-four hours, dissolved in a pint of water, for a long time, without any inconvenience to the patient, not even a reduction of appetite; and yet with the result of producing beneficial changes in various chronic diseases. Dr. BALFOUR speaks in high terms of its use in small doses, not only in acute affections, but also in chronic disorders; its efficacy not being confined to nauseating doses. Tartar emetic is also useful in minute doses, long continued, in chronic cutaneous diseases. When employed for this purpose, it may be sometimes advantageously used in conjunction with guaiac, extract of hemlock, or infusions of sarsaparilla or dulcamara.

b. *Tartar emetic as a sedative and diaphoretic.* This remedy may be useful, by reason principally of its sedative and diaphoretic powers, in doses of from an eighth to a sixth of a grain, repeated every two or three hours, in most febrile diseases, in the different phlegmasiæ, except gastritis and enteritis, and in the active hemorrhages. Its mode of action has been sufficiently dwelt upon in the remarks already made under the head of the general effects of antimonials as antifebrile and antiphlogistic remedies. In gaining these effects, it is frequently useful to combine it with some neutral salt, such as nitre or sulphate of magnesia, neither of which have the power to decompose it. Sulphate of magnesia is a particularly useful addition, when a slight action on the bowels is desired. Again, many cases exist, in which the addition of calomel, or of calomel and nitre to this antimonial proves useful, where it is desirable, in addition to an antiphlogistic effect, to produce an action on the hepatic system. The latter combination, under the name of *nitrous powders*, is frequently prescribed in the United States in febrile diseases, prepared according to the following formula: ℞ Pot. Nitrat. ʒi, Ant. et Pot. Tart. gr. i, Hyd. Chlor. Mit. gr. vi. Ft. pulvis, in chart. sex vel octo dividendus. S. One to be taken every two hours. Dr. EBERLE, on the authority of PFAFF, a German writer on the Materia Medica, recommends the union of Peruvian bark with tartar emetic, in some cases of intermittent fever, in which, from an inflammatory condition of the system, bark alone would do harm. From the use of bark in this way, the antimonial is disarmed, to a certain extent, of its emetic power, and may be given to the extent of one or two grains every three or four hours, without

producing vomiting, but with a manifest antiphlogistic effect. In judging of the propriety of this practice, it is freely conceded that bark decomposes tartar emetic, and lessens its activity; but how far it is possible by such a combination, to gain at the same time the antiphlogistic influence of the antimony, and the febrifuge impression of the bark, is a point which may well be left to future decision. If the practice should be found on experience to be valuable, a question will arise whether the increased doses of tartar emetic which may be given, are necessary only to make up for the loss of activity in the antimonial, or are really useful by being, to a greater extent, absorbed in the changed and less irritant state to which the antimonial is brought by the bark.

Tartar emetic in sedative doses operates usefully as an adjuvant to bloodletting, and the other antiphlogistic measures usually employed in active hemorrhages, and may be supposed to operate on the principle of reducing the action of the heart and arteries.

The power of tartar emetic as an expectorant has not been made a distinct head in our account of its diversified therapeutic action. This power, however, has been fully proved by ample experience; and as it is intimately connected with its diaphoretic effect, we shall mention it here. It is well known that tartar emetic in doses of from a twelfth to a tenth of a grain, causes the pulmonary exhalants to yield a thinner and more abundant secretion, and thus proves useful in some forms and stages of thoracic disease, in which the sputa is viscid, and deficient in quantity. In such cases, its expectorant power may be increased by associating it with ammoniac or squill.

c. *Tartar emetic as a cathartic and emetic.* Tartar emetic given in half-grain doses, will generally produce purging followed by diaphoresis. As an emetic, it is usually administered in the dose of two or three grains, or of a grain dissolved in a table spoonful of water, every ten or fifteen minutes until it vomits. It is often conjoined with ipecacuanha, in the proportion of one or two grains to twenty of the vegetable emetic. The method of giving it in divided doses, however, is to be preferred; for, in consequence of idiosyncrasy, the full emetic dose sometimes produces dangerous effects, such as excessive vomiting and purging, attended with colicky pains, a small and concentrated pulse, and a cold and clammy skin. After nausea is fully produced, or vomiting has commenced, the operation is to be promoted by warm water, or warm chamomile tea. The warm diluents render the vomiting easier and more copious, and prevent that excessive prostration which sometimes occurs, when, from the small bulk of the vehicle, even dangerous quantities of the antimonial are taken without the occurrence of emesis. Full vomiting being produced, it seldom fails to cause purging; so that as a general rule, whenever it acts as an emetic, it operates also as a cathartic. This double effect, however, is most usually gained by a compound solution of tartar emetic, either with sulphate of soda, forming the famous emetico-cathartic of the French School, or, what is better, with sulphate of magnesia.

In giving this antimonial as an emetic, it is sometimes added to lemonade, to the infusion of tamarinds, or even to a strong decoction of Peruvian bark. All these vehicles alter its chemical qualities; the two former, from the acids they contain, increasing, the latter, diminishing its activity. Antimoniated lemonade, the *limonade émétisée* of the French, is generally made in the proportion of two grains of the emetic salt to the pint. Full vomiting may be induced by the addition of tartar emetic to the decoction of cinchona; for though it is in part converted into a tannate of antimony, yet sufficient activity remains for that purpose. The repeated vomitings sometimes produced by the *bolus ad quartanam*, administered at the hospital La Charité, in Paris, and which consists of sixteen grains of tartar emetic, associated with one or two drachms of bark, sufficiently attest the power of the antimonial, even after the decomposition which it undergoes from this vegetable.

The emetic effect of this antimonial may sometimes be gained, in cases where it cannot be taken by the mouth, by giving it in the form of enema, in doses of twenty grains or more, dissolved in a pint of water; but when thus administered, it generally acts exclusively as a cathartic, and as such forms a most valuable resource in the treatment of obstinate obstructions of the bowels.

Tartar emetic, as a vomit, is characterized, in its operation, by certainty, strength, and permanency of effect. It remains longer in the stomach than ipecacuanha, produces more frequent and longer continued efforts to vomit, and exerts a more powerful impression on the system generally. As an emetic, its use is indicated where the object is not merely to evacuate

the stomach, but to agitate and compress the liver and other abdominal viscera. By the extension of its action to the duodenum, it causes copious discharges of bile, and hence forms an appropriate remedy in those diseases in which there is an accumulation of that secretion. It is employed as an emetic in the commencement of fevers, especially those of an intermittent or bilious character, in jaundice, whooping-cough, croup, chorea, idiopathic tetanus, and a long catalogue of other diseases. It is contra-indicated in diseases of debility, in the advanced stages of febrile affections, and in fevers attended with extreme irritability of stomach.

Laennec treated with success three cases of chorea and two of idiopathic tetanus, by large doses of tartar emetic. Its mode of operation is not distinctly stated; but it may be presumed that it acted by vomiting and purging, and by that extreme relaxation of the muscular system, which is found to be connected with emetic doses of this antimonial.

Advantage has been taken of the extreme muscular relaxation produced by this substance to facilitate the reduction of dislocated limbs. This practice appears to have originated with Mr. Wilmer, and since the publication of his paper, its value has been repeatedly verified in surgical practice. Bloodletting to fainting answers the same purpose; but the objection to this expedient is that large quantities of blood must often be drawn, and that the patient is left proportionally weak after the reduction of the limb. Taking advantage of the same power of producing muscular relaxation, Dr. Chapman has used tartar emetic by way of enema, with encouraging success, in a case of idiopathic locked-jaw.

d. *Tartar emetic as a contro-stimulant.* Rasori, professor of clinical medicine at Milan, published in 1800 his views on the therapeutic action of tartar emetic in large doses, in controlling inflammatory excitement in certain phlegmasial diseases, particularly peripneumony. He denoted the condition of high excitement characterizing these diseases, as the *diathesis of stimulus;* and hence he called tartar emetic in large doses, as administered by him, a *contro-stimulant.* Peschier of Geneva, Laennec, and many other practitioners confirmed the general accuracy of his results; and no one at present calls in doubt the curative power of tartar emetic, in large doses, in the treatment of peripneumony. It has also been recommended, in the same doses, in several other diseases; such as hemoptysis, pleurisy, articular rheumatism, apoplexy, traumatic tetanus, encephalitis, phlebitis, puerperal peritonitis, &c. Numerous observations have incontestably proved, that tartar emetic, given by the method of Rasori, will control most acute inflammations; but it is doubted by many physicians, whether the practice is safe, and whether it does not infinitely more harm to the digestive organs, than good in subduing local inflammation in other parts. The particular mode in which it acts, according to the views of Rasori, will be detailed in another article: (see *Contro-stimulant.*) Some have supposed its mode of action, when given by the method of Rasori, to be sedative; but its mere power to diminish inflammatory excitement by no means proves it to be so. We believe, with Broussais, that it acts as a powerful revulsive on the stomach; but, without entering, in detail, upon the theory of its operation, we shall use the term *contro-stimulant*, to express the mode of action, whatever it may be, of tartar emetic, when given in the manner recommended by Rasori.

According to this last writer, tartar emetic, in large doses, so as to produce its contro-stimulant operation, is borne only in the sthenic or inflammatory condition of the organism, or, as he expresses it, during the existence of the diathesis of stimulus. This explanation of the tolerance of the remedy, in doses which under other circumstances would prove poisonous, is consonant with pathological principles; but while Trousseau admits that the remedy is never better supported than when the inflammatory symptoms are most intense, he nevertheless asserts that he has seen tolerance to be perfectly established in patients excessively weak. He, therefore, denies that the inflammatory condition is essential to the tolerance of antimonials, and explains the fact that they are not well borne in health, by the circumstance, that a rigorous diet, an essential condition of tolerance, is not adopted. The different view of Trousseau on this subject may be explained by the fact that he prefers the use of the oxides, in obtaining the contro-stimulant effect of antimony, preparations which produce incomparably less irritation and disturbance of the system than tartar emetic.

The chief disease in which Rasori has given tartar emetic as a contro-stimulant is *peripneumony.* His principles of treatment may be summed up under the following heads: 1. To treat the disease through-

out by tartar emetic; 2. To adopt this medicine as the principal, and sometimes the only remedy in the disease; 3. To diminish by its use the number of bleedings, or to do away the necessity of this evacuation altogether; 4. To give the remedy in doses which formerly the boldest practitioners never thought of employing; amounting to one or more drachms in the twenty-four hours, and to several ounces in the course of the disease, without producing either vomiting or purging.

Rasori, and the Italian physicians, in treating peripneumony, generally give at first from ten grains to a scruple of tartar emetic, and increase the dose gradually to one or several drachms in the twenty-four hours, in proportion as the tolerance of the remedy is gradually established. Laennec, who with M. Kapeler, were among the first to call attention to the method of Rasori in France, adopted it with slight modifications. When a patient with peripneumony would bear a bleeding, Laennec began the treatment by drawing from eight to sixteen ounces of blood; and rarely repeated the venesection, unless in individuals attacked with diseases of the heart, or threatened with apoplexy or some other sanguineous congestion. He states, however, that he has frequently and rapidly cured intense peripneumonies without recourse to bleeding, though generally he resorted to it. Immediately after the bleeding, he gave a grain of tartar emetic in two fluidounces and a half of sweetened aromatic water, and repeated the dose every two hours, until six had been taken; after which the patient was allowed to rest for seven or eight hours, if the symptoms were not urgent, and a disposition to sleep was manifested. But if the disease was already advanced, the oppression great, the head seized, and both lungs affected, or if one of them was invaded throughout, he was in the habit of continuing the tartar emetic without interruption, until the symptoms were mitigated, and the stethoscope indicated an improvement. When, however, the aggravating circumstances, above mentioned, were all united in the same case, his practice was to increase the dose of the antimonial to a grain and a half, two grains, or even two grains and a half, but given always in the same amount of vehicle.

Laennec remarks, that some pneumonic patients support tartar emetic, administered in this manner, without vomiting or purging. A majority, however, vomit several times, and have five or six stools the first day; but afterwards they experience but moderate evacuations, and often none at all. After the tolerance of the medicine has been established, it is asserted by Laennec, that the patients often become constipated, so as to require the use of purgative enemata.

In describing his mode of practice, Laennec proceeds to remark, that, when evacuations continue to the second day, or when there is reason to believe that the tartar emetic will be supported with difficulty, he adds to the six doses to be taken in twenty-four hours, one or two ounces of the syrup of diacodion (syrup of poppies), an addition which he admits is contrary to the theoretic views of Rasori, but which his own experience has proved to be useful. He declares further that, in general, the effect of the tartar emetic is never more rapid than when it causes no evacuation whatever; though sometimes its good effects are accompanied by a general sweat. Though he considers frequent vomiting and abundant purging to be feared, on account of the weakness, and the irritation of the alimentary canal which they produce, yet he avers that he has effected remarkable cures, where the evacuations were very abundant. "I have," says he, "very rarely met with pneumonic patients who could not support tartar emetic, and such cases occurred in my first trials; so that this inconvenience is attributable, perhaps, to the inexperience and want of confidence of the physician, rather than to the method itself. In many cases, where a patient would support, only tolerably, six grains of tartar emetic with syrup of diacodion, one day, I have given him the next day nine grains with perfect tolerance. At the end of twenty-four or forty-eight hours at most, and often at the end of two or three hours, a marked melioration of all the symptoms is obtained. Sometimes, even, a patient who appears to be doomed to certain death, is, at the end of a few hours, out of danger, without having experienced any crisis or evacuation, or any other notable change than a progressive and rapid improvement in all the symptoms; and the exploration of the chest explains the reason of the sudden change, by detecting all the signs of resolution."

Laennec states that effects equally striking may be obtained at all stages of the disease, even when a great part of the lung is infiltrated with pus!

From the moment an improvement takes place, Laennec conceives that the medicine may be continued with the certain result of completing the resolution,

without inducing fresh commotions; a circumstance in which mainly consists the great practical advantage of tartar emetic over bloodletting as a remedy. By bleeding, he admits that we almost always obtain a diminution of fever, of oppression, and of bloody expectoration; but at the end of some hours, these symptoms again increase; and this often happens five or six times, after the employment of as many bleedings. Now LAENNEC affirms that he had never seen similar relapses under the use of tartar emetic; and that when this antimonial was employed, the weakness during convalescence was never so protracted, or excessive, as when the patient was treated by repeated bleedings.

We by no means subscribe to the accuracy of all the above views of LAENNEC, in relation to the tartar emetic treatment in peripneumony; but though his assertions may have been too general on some points, and his plan of practice too little regulated by the state of the alimentary canal, still the opinions of so distinguished an authority must always be viewed as important, and entitled to great respect.

M. PESCHIER of Geneva, advocates the contro-stimulant use of tartar emetic in peripneumony, and in fluxions of the chest generally; but his mode of using it appears by no means precise, and not at all regulated by the state of the system. When a determination to the skin was manifested, he added nitric, muriatic, or acetic ether to the antimonial; and when there existed dysuria, and dry heat of the skin, he conjoined nitre. He generally began the treatment with six grains in the twenty-four hours, and increased the quantity three grains daily, until the dose reached twelve or fifteen grains, a quantity which he did not exceed, as this was found sufficient. In cases in which, from the great weakness of the patient, he was induced to direct so small a dose as a grain, or a grain and a half, it produced fatiguing effects, without any curative result. In none of the cases which he treated, was bloodletting, either general or local, employed, but blisters were occasionally resorted to.

Without implicitly relying on the results obtained by RASORI, LAENNEC, and M. PESCHIER, from the use of tartar emetic as a contro-stimulant, their general tenour is sufficiently coincident to satisfy the reader of the remarkable controlling power of this remedy, when thus employed, over acute pneumonic inflammation. Still the question arises how far the practice is a safe one, and how far it may be used to replace the ordinary curative means, of general and local bloodletting, blistering, antiphlogistic medicines, demulcents, and anodynes. In determining this question, the more recent results deduced by M. RAYER from careful observations made on a number of pneumonic patients at the hospital La Charité, will have an important bearing, from the impartial manner in which they appear to have been conducted. M. RAYER arranges his observations under the three heads, of effects on the digestive organs, on the organs of respiration, and on the circulation and blood.

Effects on the digestive organs of pneumonic patients.—1. Tartar emetic, dissolved in a small quantity of sweetened vehicle, produces vomiting less easily than when it is dissolved in pure water, and assisted by the administration of warm and nauseating drinks.

2. The tolerance of the remedy was obtained in a *few* patients from the first day, without any apparent reason for its want of action on the stomach or bowels. Now this tolerance is affirmed to take place in a *great number* of patients by RASORI, and in *many* by LAENNEC.

3. The majority of the patients vomit on the first day, after having taken the first doses. They experience at first a general uneasiness with disposition to vomit, afterwards paleness, and contraction of the volume of the body. After vomiting, reaction and heat return in the course of half an hour or an hour. During the interval, the patient is pale, with a small concentrated pulse, and yet he declares himself to be better.

4. Some patients, from irritability of the digestive organs, support the contro-stimulant method with difficulty, being affected with violent vomitings, colics, and twistings of the bowels.

5. Tolerance is established more freely and permanently in relation to the stomach than to the bowels; many patients experiencing purging without vomiting after the first days.

6. In patients with healthy stomachs, the vomitings and purgings were not preceded or followed by pains in the abdomen, and were not accompanied by any pain except that attendant on the act of vomiting. The next day the stomach and bowels were rarely affected with pain.

7. The alimentary canal soon loses its power of tolerance; for if the treatment be discontinued for a day or two, the same doses, which had ceased to produce vomit-

ing and purging, and even smaller doses, will reproduce them.

8. Tartar emetic may be given for many days together in very large doses to some pneumonic patients, without producing any evident inflammation of the alimentary canal; but this is not always the case.

9. If on the one hand, the generality of physicians have exaggerated the irritant properties of tartar emetic; on the other, the *contro-stimulists* have been guilty of an opposite exaggeration, far more dangerous.

10. When it is wished to establish a tolerance of the remedy, it is better to augment the dose gradually, or even to diminish it, rather than to employ opiates, which give rise to a factitious tolerance, masking the effects of the antimonial on the digestive organs.

11. Tartar emetic, administered in large doses, produces sometimes inflammation of the stomach and bowels; but these artificial inflammations are, in general, less serious and obstinate than those generated without appreciable causes; and when they are not kept up by the too long-continued action of the remedy, nor aggravated by a previous affection of the stomach, they yield, with sufficient readiness, on the suspension of the remedy, or to the use of a few local bleedings.

12. During the convalescence of pneumonic patients, in whom resolution is progressing, tartar emetic, in the dose of five or six grains, appears to excite the feeling of hunger. After tolerance has been established, digestion does not appear to be deranged by the remedy, when administered three hours before or after a meal. It may be proper to remark, that many of M. Rayer's patients were on half-diet.

13. In this paragraph, M. Rayer reports the post-mortem appearances observed in the few pneumonic cases which he lost. These have been detailed in a preceding part of this article. (See p. 54.)

Effects on the organs of respiration.—1. The effects of tartar emetic, in large doses, upon the organs of respiration, vary according to the intensity of the peripneumony, and to the disturbance, more or less serious, which it impresses on the digestive organs. M. Rayer has seen peripneumonies disappear in forty-eight hours after repeated vomitings and purgings by tartar emetic. He has observed other cases in which the disease progressed, although there was a marked tendency to tolerance. In a considerable number of cases, the cough and bloody expectoration diminished in an evident manner, and in the following days the stethoscope detected the progressive march of resolution.

2. By means of this treatment, and by the use solely of tartar emetic, many peripneumonies, both simple and double, were completely cured, and in as short a time as when treated by bloodletting.

3. The good effects of tartar emetic are never more evident, according to the opinion of M. Rayer, and in opposition to that of Rasori, than when it produces abundant evacuations. Indeed, the absence of tolerance, signalized by Laennec as one of the contra-indications of tartar emetic, is, according to M. Rayer, on the contrary, oftener one of the conditions most favourable to its employment, provided the stomach be not inflamed.

4. The first days of the use of tartar emetic in recent peripneumonies are distinguished by a decided melioration of the disease; but this improvement becomes afterwards less and less evident, from the tolerance of the remedy, and from the fact that those diseased conditions disappear first which are the least fixed.

5. The property attributed to tartar emetic of augmenting the energy of interstitial absorption, so as to resolve pulmonary hepatizations after bleedings have lost their influence, has appeared to M. Rayer to be a very questionable one in the majority of cases.

6. The quantity of tartar emetic necessary to effect the cure of peripneumony varies from several drachms to one or more ounces, according to the extent of the pulmonary inflammation, and the duration of the disease before the treatment is commenced.

Effects on the circulation and blood.—When tolerance is established, the action of tartar emetic on the circulation is scarcely appreciable; on the contrary, when vomiting is about to take place, and during the existence of colicky pains, the pulse becomes concentrated. With regard to the buffy appearance so uniformly exhibited by the blood in pneumonia, M. Rayer ascertained that this appearance was not modified by the tartar emetic treatment.

M. Rayer sums up his results by declaring that, in his opinion, the treatment of peripneumony by tartar emetic, as an *exclusive method*, is inferior, in a majority of cases, to the treatment by bloodletting.

Before resorting to the method of Rasori, Rayer further remarks, it is necessary to be satisfied as to the condition of the digestive organs. It must not be for-

gotten that many individuals have latent affections of the stomach, and that certain results of chronic gastritis in old persons, such as thinning and softening of the stomach, are always aggravated by tartar emetic. Moreover, this method is hurtful, when the pneumonia is complicated with gastritis. But when the integrity of the digestive organs is well ascertained, it will be proper, according to M. Rayer, to employ tartar emetic and bleeding concurrently in the treatment of peripneumony. This combined method he conceives to be preferable to all others at the commencement of pulmonary inflammations; but instead of *aiming to produce tolerance*, it is preferable, according to him, to *obtain abundant evacuations.* Six, eight, ten, or fifteen grains of the antimonial are considered sufficient by him to produce this result; it being unnecessary to increase the quantity daily until the dose reaches a drachm. He, accordingly, characterizes it as a blameable temerity to imitate Rasori, who has often given the almost incredible quantity of an ounce in the course of a day. Finally, M. Rayer recommends, that in proportion as resolution progresses, the dose of the tartar emetic should be diminished, having care always to continue it for some time after the disappearance of the crepitant rhonchus.

We have presented thus fully the results of M. Rayer, on account of their intrinsic value, and of the precision with which they are reported. But we cannot admit all his therapeutic views, and particularly that one which asserts that the contro-stimulant action of tartar emetic is never more marked than when it produces copious evacuations, and that the establishment of tolerance is rather detrimental than useful to that action. The great authority of Laennec is opposed to it, and the observations of Rasori, M. Peschier, M. Trousseau, and of many other practitioners, establish a diametrically opposite conclusion. We admit the concurrent benefit of bloodletting, and cannot conceive how it could interfere with the curative operation of the tartar emetic. Dance agrees, on this point, with M. Rayer; but M. Trousseau states emphatically, as the result of his experience, that bloodletting in peripneumony, so far from assisting, impedes the operation of antimony. He asserts that resolution is not completed for a long time, when bleeding is employed; while it is never more rapid than under the sole influence of antimony. In short, he declares it as the chief merit of the cure of peripneumony by antimony, that there is *no convalescence.* Patients, according to him, are sometimes brought, in the course of a few days, from the brink of the grave to a state of apparent health so satisfactory, that, without the indications of the stethoscope, it would be impossible to believe that there had existed a dangerous peripneumony. Of fifty-eight pneumonic patients treated by M. Trousseau, none of whom were bled in the hospital, and five only before admission, but two died. The cases most rapidly cured by the antimony were precisely those in which the disease was most recent, the fever most vehement, the pulse most full and vibrating, the skin hottest, the oppression greatest, the local pain most acute, and the expectoration most bloody.

Tartar emetic as a contro-stimulant has been given in *hæmoptysis* and *pleurisy*, but with doubtful advantage. Laennec contended that it had the power of controlling the inflammatory action in the latter disease; but M. Trousseau reports that, in ten cases in which he tried antimony in acute pleurisy, no reduction of the diseased excitement was obtained.

According to Laennec, acute *articular rheumatism*, is, after peripneumony, the inflammatory disease in which tartar emetic in large doses appeared to him to be the most efficacious. The mean duration of rheumatism, treated by this curative plan, was seven or eight days; while, by the ordinary method of treatment by bleeding, &c., it is known to last from one to two months. The medicine, however, is less efficacious, where muscular and articular rheumatism are combined. Laennec sometimes though rarely observed relapses after articular rheumatism, when the medicine had not been discontinued; and he was obliged, in two cases only, to interrupt its use, because tolerance could not be established. Of thirteen rheumatic cases treated by Laennec, tartar emetic proved highly useful in eight, without effect in two, hurtful in one, and of doubtful utility in two.

M. Rayer dissents from Laennec as to the value of the contro-stimulant practice by tartar emetic in rheumatism; and rests his dissent on the variable character and duration of this disease, which forbids the adoption of any opinion as rigorously exact, in favour of any particular plan of treatment. Upon the whole, he comes to the conclusion, in opposition to Laennec, that the plan by bloodletting, and by revulsives applied to the skin, is preferable to that by tartar emetic in large doses. Besides, tartar emetic is strongly contra-

indicated in cases in which the rheumatic disease is partly seated in the digestive organs, or likely to be translated to them. Rayer concludes by remarking "that the employment of tartar emetic in large doses in rheumatism is more rarely indicated than in pneumonia; for the danger to life, in the latter disease, is such as to make it admissible to produce a momentary or sustained revulsion on the stomach and intestines; while it is by no means demonstrated that this is equally true with regard to rheumatism."

M. Trousseau reports his experience with the use of large doses of tartar emetic in acute articular rheumatism, and is of opinion that, when of service, it does good by operating as an emetic and cathartic, rather than as a contro-stimulant. Its good effects, however, are by no means so constant as in pneumonia; and so far from acting on the principle of tolerance, it is never so useful, according to him, in acute rheumatism, as when it produces vomiting and hypercatharsis. It is on this account that M. Trousseau denies to the antimonials the possession of any special curative power in this disease, and attributes their efficacy exclusively to their action as evacuants.

Laennec and other practitioners have employed contro-stimulant doses of tartar emetic in *apoplexy*. Of eleven cases treated on this plan, six were cured; but as bloodletting was used at the same time, it is impossible to determine the precise curative value of the tartar emetic. In some cases of apoplexy, Laennec has gradually carried the dose to a drachm and a half; but it should be recollected that, in consequence of the lesion of the nervous system which exists, the tolerance of the antimonial in this disease is often apparent, not real, and, therefore, cannot be held as proof of the safety of the stomach.

MM. Delpech and Lallemand have recently extended the contro-stimulant use of tartar emetic to the prevention and cure of *tetanus* from *traumatic lesions*. Their results were made known by M. J. Franc, one of their pupils, in a Memoir published in 1834, from which it appears that the exhibition of tartar emetic in large doses prevents the accidents which follow those lesions; and, when these accidents have already taken place, forms the most efficacious means of treating them. By this treatment, M. Lallemand has cured, in many cases, a slight and commencing *encephalitis*, the consequence of traumatic lesions. The dose of the antimonial which he employs in the twenty-four hours, is generally eight grains, associated with the syrup of poppies. Delpech, however, gives the remedy in simple aqueous solution without any addition.

M. Trousseau reports several cases of phlebitis and puerperal peritonitis, successfully treated by tartar emetic and other antimonials, used as contro-stimulants.

In concluding our remarks on the contro-stimulant use of tartar emetic, it is hardly necessary to add that its employment in this way is strongly contra-indicated in inflammation of the stomach and bowels. M. Fabre has reported a case of combined bronchitis and gastritis, in which the administration of twelve grains of tartar emetic was followed by bloody vomitings, convulsions, and delirium. M. Vacquié has recorded a case of acute gastro-peritonitis, made to terminate in gangrene, and M. Barbier, two cases of inflammation of the stomach, exasperated and rendered rapidly mortal, by the use of large doses of this antimonial. Too much caution, therefore, cannot be exercised in its administration in diseases in which the alimentary canal is implicated.

e. *Tartar emetic as a corrosive.* Tartar emetic, when applied in a solid state, or in concentrated solution to the different tissues, gives rise to a violent inflammation ending in ulceration or corrosion of the part. When thus applied to the skin, as by means of tartar emetic ointment, it first produces vesicles, which, in the progress of the inflammation, next become pustules, and afterwards ulcers, more or less large and deep according to the susceptibility of the skin, and the strength and duration of the application. It is to the therapeutic effects of this artificial cutaneous eruption, thus excited by the external application of tartar emetic, that we shall confine our remarks, under the present head.

The external application of tartar emetic appears to have been first proposed as a remedy by Dr. Bradley in 1773, in a paper detailing its efficacy in rheumatic affections, and published in the Memoirs of the Medical Society of London. He very correctly describes the pustules as resembling those produced by small-pox. In several of Dr. Bradley's cases, the eruptions were not confined to the part subjected to the frictions, but extended to other and distant parts of the body; and in one case the eruption was preceded by restlessness, and a slight degree of nausea.

No further observations of importance appeared on the external use of this anti-

monial, until January 1821, when Dr. Robinson published a paper in the London Medical Repository, on its curative efficacy in whooping cough, when employed in the way of frictions on the region of the stomach. The next contribution on the subject was from the pen of the late Dr. Jenner, dated in November of the same year. In this highly important paper, the Doctor, after sketching the observations of his predecessors in the same field of inquiry, details his success, more or less complete, with the use of tartar emetic ointment in mania, hysteria, hypochondriasis, asthma, bronchitis, hemoptysis, chorea, chronic hepatitis complicated with pulmonary irritation, and some other diseases. The external use of tartar emetic, with a view to its producing artificial eruptions, having been thus introduced to the notice of the profession, under the sanction of Jenner's great name, it has subsequently been tried in a number of diseases, but particularly in pulmonary affections, with more or less success. The rules which should govern its application, according to the character of the morbid action which it is intended to control, will be detailed under the head of the individual diseases in which, from experience, its efficacy seems to be established.

Besides being used as an ointment, either in frictions or applied spread on linen, tartar emetic, in order to produce its eruptive effect, may be sprinkled on the surface of some adhesive plaster, which is then to be applied to the part intended to be affected, previously shaved if covered with hairs. Of these several methods, the plan by using adhesive plaster gives the least trouble, and is preferable in maniacal cases, in which frequently the patient will not submit to frictions; but when thus used, the progress of the eruption is not so easily watched, and, therefore, there is more danger of the inflammation being excessive, and terminating in deep ulcerations difficult to heal. When a speedy action is desired, as in tetanus or hydrophobia, or when insusceptibility of the skin exists, it has been recommended to apply cupping-glasses to the part, either with or without scarifications, before subjecting it to the action of the tartar emetic.

According to Dr. Robinson, the modus operandi of tartar emetic, externally applied, is peculiar, and quite different from that of a blister, which only raises the cuticle. Dr. Jenner coincides in opinion with Dr. Robinson as to the peculiar effect of tartar emetic as an external irritant. By tartarized antimony, Dr. Jenner remarks, "we can not only create vesicles, but we can do more; we have at our command an application which will at the same time both vesicate, and produce diseased action on the skin itself, by deeply deranging its structure beneath the surface. This is probably one cause why the sympathetic affection excited by cantharides, and those changes produced by tartar emetic, are very different."

Metallic antimony. M. Trousseau asserts, as the result of his experience, that antimony, perfectly pure and porphyrized, has an action almost as energetic as that of tartar emetic. He finds it difficult to explain this fact, on account of the insolubility of the metal; and though it may be admitted that it is oxidized in the stomach, still the difficulty remains of explaining why it is more active than the oxides themselves.

Notwithstanding these positive assertions of Trousseau, M. Rayer denies to pure antimony the possession of any activity, and asserts that he has given it in doses of several drachms without producing any effect. Perhaps the different results obtained by these experimenters may be explained on the supposition, that M. Rayer did not use the metal in a porphyrized state.

M. Trousseau states that he has exhibited porphyrized metallic antimony with advantage in peripneumony, articular rheumatism, and catarrh. It may be given in pills or powder, mixed with magnesia or prepared carbonate of lime, in doses varying from eight grains to a drachm. Triturated with lard, in the proportion of two parts of the metal to one of the unctuous substance, it forms a preparation which may be substituted for tartar emetic ointment.

Prepared sulphuret of antimony. Syn. *Crude antimony.* This preparation has been used principally in scrofula, glandular obstructions, gout, chronic rheumatism, and chronic diseases of the skin. Hufeland considered it applicable to those cases of scrofula in which, from the susceptibility of the stomach, the use of other antimonials excites nausea, vomiting, and diarrhœa. Guldbrand of Copenhagen has published a paper on its good effects in gout and rheumatism, given every night in the dose of half a drachm; but as infusion of elder-flowers and purgatives were used at the same time, it is difficult to decide on the degree of efficacy of the sulphuret. It is, perhaps, in chronic diseases of the skin, that the good effects of the prepared sulphuret have been most

prominently evinced; but even here Rayer believes that more is to be attributed to the diet and rest which are usually enjoined at the same time, than to the antimonial itself.

The chief therapeutic effect of sulphuret of antimony is supposed to be alterative; but, according to Cullen, it produces diaphoresis, and in large doses nausea and even vomiting. It is given in various doses, from a few grains up to half an ounce or an ounce daily. The average dose is about twenty grains. In the treatment of cutaneous diseases, it is usually exhibited in conjunction with conium, dulcamara, or guaiacum.

Sulphuret of antimony enters into the composition of a number of European formulæ, intended as antirheumatic and antisyphilitic remedies; such as the antirheumatic powder of Kœmpfer and lozenges of Kunckel; and the antisyphilitic tisan of Feltz and decoction of Arnoult. It is also an ingredient in the English quack medicine called Spilsbury's drops, in which it is formed into a tincture with corrosive sublimate, gentian root, orange peel, and red saunders.

There are great objections to the use of prepared sulphuret of antimony as a medicine, on account of its unequal operation, which arises from two principal causes,—the condition of the stomach, and the variable purity of the medicine itself. If it meet with acid in the stomach, it operates violently, even though pure; but in point of fact it is seldom so. From the experiments of Guibourt, it has been shown that the ordinary sulphuret of antimony used in pharmacy, contains, on an average, more than *one per cent. of sulphuret of arsenic.* It is on account of the presence of this impurity, that the decoction of the antimonial sulphuret is much more active than an equal quantity of it in substance; for the insoluble sulphuret of arsenic which it contains, becomes converted by the boiling heat, into the soluble and eminently poisonous arsenious acid. These facts show that this antimonial deserves no confidence, and should be entirely discarded from medical practice.

Kermes Mineral. Syn. *Hydrosulphate of antimony.* This antimonial first came into vogue as a remedy in 1720, the secret of its preparation having been purchased in that year by the French government from a surgeon named La Ligerie. This fact shows the high estimation in which it was originally held.

The action of kermes on animals is far less energetic than that of tartar emetic. Two drachms of it placed in the cellular tissue of a rabbit produced no appreciable effect. Taken in doses of from four to eight grains by a healthy person, it sometimes gives rise to vomiting, at other times to stools accompanied by a general feeling of indisposition; but occasionally no effect whatever is produced.

Kermes mineral, according to the dose, and the circumstances under which it is exhibited, is supposed to be capable of acting either as a diaphoretic, expectorant, cathartic, or emetic. As a cathartic and emetic, however, it is now seldom employed. It has been principally used in bronchitis, pulmonary catarrh, and in the advanced stages of peripneumonies, with a view to its expectorant effect. To produce this effect, it is generally advised to be given in a dose so moderate as to excite neither nausea nor alvine evacuations; but Rayer contends that its so-called expectorant operation is never more manifest than when it acts in a decided manner on the alimentary canal; and that when it facilitates expectoration in bronchitis, it does so by acting as a derivative from the lungs to the stomach and bowels.

To test the value of kermes administered in small doses as an expectorant, M. Rayer gave it, in grain doses, in a number of cases of pneumony, pulmonary catarrh, and phthisis, at the hospital Saint-Antoine, and without any evident effect in modifying the character of the pulmonary secretion. This secretion was indeed found constantly to change; but not more certainly during than without the use of the remedy.

Although denying the beneficial effects of small doses of kermes in pulmonary affections, Rayer is disposed to admit its power in lessening inflammation of the bronchi, when given in doses sufficiently large, sensibly to irritate the stomach and bowels. In the beginning of peripneumonies, the dose may be carried, according to his views, to 20, 30, 60, or even 80 grains, and often without producing colicky pains, vomiting, or diarrhœa; but its good effects in this disease are less marked than when large doses of tartar emetic are employed. When given in these large doses, it may be considered as acting as a contro-stimulant.

Kermes mineral is sometimes exhibited, combined with opium, as a sudorific in chronic rheumatism; but its effects are probably far inferior to those of Dover's powder in the same affection. Conjoined with calomel, it was administered by Barthez with success, in visceral obstructions.

The dose of kermes varies, according to the intention in giving it, and the length of time it is continued, from one or two grains, to twenty, forty, or even sixty grains. In doses of one or two grains, its effect is hardly appreciable; yet, if we may believe RAYER, it is capable in those doses, when it does not produce vomiting, of awakening latent inflammation of the stomach and bowels. In the amount of five grains it often causes nausea and vomiting, but these effects are by no means constantly produced. The late Dr. DUNCAN of Edinburgh states that he has given ten grains three times a day, often without producing any appreciable effect; and the still larger doses which are given, are borne, in consequence only of the influence of habit.

The best form of administration of kermes is suspended in mucilage; though it may be given in pills and lozenges. When exhibited in the liquid form, it sometimes renders the expectoration reddish; an appearance which might impose upon the practitioner, if not aware of its cause.

The uncertainty which obtains in regard to the dose of kermes mineral probably arises partly from the variable nature of the preparation, and partly from the state of the stomach as to acidity. The golden sulphur and the precipitated sulphuret of antimony, both weaker preparations, are often confounded with kermes mineral; while the preparation itself is probably not uniform, as obtained by different formulæ. On the other hand, acids, when contained in the stomach, render the preparation far more active, by effecting its solution.

Golden Sulphur of Antimony. This preparation, which was more anciently known than the kermes, possesses, generally, the same properties, when administered in double or triple the dose. If it possesses any peculiar property, it is, according to RAYER, that of producing sweat more certainly than the kermes. It has been recommended especially in chronic diseases of the skin, chronic rheumatism, scrofula, and gout.

Precipitated Sulphuret of Antimony. This preparation, like the two last noticed, is diaphoretic, cathartic, or emetic, according to the dose. Like them also, it is uncertain as to strength, and variable in its effects, according to the condition of the stomach as to acidity. Its dose may be considered as intermediate between that of the kermes and of the golden sulphur; as it contains more sulphur than

the former, and less than the latter. It is seldom given alone, but generally in combination with an equal quantity of calomel, and twice its weight of guaiac, in the form of the *compound calomel pills* of the British Colleges, generally called *Plummer's pill;* as the combination was originally, at the recommendation of Dr. PLUMMER, admitted into the Edinburgh Pharmacopœia. These pills are used as an alterative in secondary syphilis, and in cutaneous eruptions, especially those of a syphilitic character, or conjoined with henbane or hemlock in chronic rheumatism. Five grains of the mass contain somewhat more than one grain, each, of the precipitated sulphuret and of calomel.

Butter of Antimony. Syn. *Chloride of antimony; Muriate of antimony.* This preparation is only used as an escharotic, being occasionally employed to cauterize poisoned wounds, such as those occurring in dissecting, or occasioned by the bites of rabid animals or venomous serpents. It is also sometimes used to destroy warts, vegetations, and carious bone. It is the most powerful caustic employed by the surgeons, and hence requires to be used with the greatest caution. It is very conveniently applied by means of a little roll of lint, previously made to imbibe a portion of the caustic. As this escharotic is liable to absorb moisture from the air, and thus to become weaker, it should be kept in a well-stopped bottle.

Butter of antimony, as an escharotic, is seldom used in the United States; and considering its extreme activity, and the difficulty of limiting its operation to the precise parts intended to be destroyed, it may well be doubted whether its use may not in all cases be superseded by that of other and more manageable caustics.

Oxides of Antimony. These oxides, as already stated, are the protoxide, and antimonious and antimonic acid. With them may be associated the powder of Algaroth, as the protoxide containing muriatic acid, and diaphoretic antimony, as chiefly consisting of antimonic acid.

TROUSSEAU asserts, generally, that the three oxides of antimony are those antimonials which act with the greatest advantage as antiphlogistics and contro-stimulants; their dose varying from six grains for an infant, to a quarter or half an ounce for adults in the twenty-four hours. These statements, however, are deficient in precision; for it can hardly be admitted that the three antimonial oxides operate on the system precisely alike, and may be given in the same dose. On

the contrary, we have good authority for believing that, while the protoxide is medicinally efficacious, the deutoxide (antimonious acid) is nearly inert, and the tritoxide (antimonic acid), eminently active. Thus RAYER states that the antimonic acid is irritant, emetic, and poisonous, its dose varying from the tenth of a grain to four grains.

In the different accounts given of the therapeutic action of antimony, it is frequently stated that the *white oxide* has been found useful in particular forms of disease. Now no designation of an antimonial preparation could possibly be more indefinite than this; for all the antimonial oxides are, under certain circumstances, white. What adds to the confusion is that the snow-white oxide obtained by burning the metal, formerly called the *argentine flowers of antimony*, is called by some authors the protoxide, by others, the deutoxide; while the washed diaphoretic antimony, supposed to consist of the tritoxide, united with a small portion of potassa, is denominated, in the French Codex, the *white oxide of antimony!*

One doubt connected with this subject, however, has been removed by THENARD and BERZELIUS, who agree in considering the oxide obtained during the combustion of the metal as really the protoxide; though certainly, we may add, in a different state of aggregation from that of the same oxide, when obtained by means of nitric acid and washing with water, as mentioned under the chemical head. In the absence of more precise information, we shall assume that the white oxide, experimented with by MM. TROUSSEAU and BONNET, under the auspices of M. RÉCAMIER, at the Hôtel-Dieu, was the white protoxide, probably obtained by the combustion of the metal. In the mean time, we shall not consider, in the present state of our knowledge, the antimonious and antimonic acids as worthy of being specially noticed as therapeutic agents.

The principal disease, in which the white oxide was used at the Hôtel-Dieu, was peripneumony. The plan pursued by M. TROUSSEAU was to commence with a large dose of the oxide, amounting to a drachm for women and youths, and to a drachm and a half for adults and old men. The next day, he increased the dose one-half, and continued the treatment at that dose, until the febrile symptoms were completely dissipated, or for two days longer. Afterwards, he diminished the dose one-fourth every second day; while, in the mean time, the amount of food was progressively increased. During convalescence, the patient should not take the oxide within the hour preceding or following a meal.

Since the particular attention of the profession has been called to the treatment of peripneumony by the white oxide of antimony, several French practitioners, among whom are MM. BOUILLAUD, ANDRAL, SANSON the elder, and MARTIN SOLON, have tried the medicine, and borne testimony to its good effects. More recently (May 1834), M. FINAZ has published a paper on the same oxide, and adds his testimony in favour of its remarkable efficacy in the disease referred to. This practitioner makes an observation which supports our opinion that the white oxide of antimony, intended as the remedy in peripneumony, is really the argentine flowers; for he remarks that the medicine did not produce uniform effects, when obtained from different apothecaries; but that his success was constant, when he used the oxide *prepared by sublimation.*

Powder of Algaroth. Syn. *Mercurius vitæ; Submuriate of antimony; Nitro-muriatic oxide of antimony. Oxychloride of antimony.* The general sentiment of chemists is that this preparation is the protoxide of antimony, containing a variable quantity of muriatic acid, or chlorine. Be this as it may, it is certain that it is a compound, very variable in its effects, and, therefore, entitled to no confidence. In the dose of from one to four grains, it is sometimes violently emetic; and in still larger doses, it is capable of producing dangerous consequences. According to several authorities, it sometimes produces salivation. From its active and variable qualities, it ought never to be prescribed as a substitute for the protoxide; but this oxide should be obtained either in the form of the argentine flowers, or, according to the recommendation of Dr. BARKER, of Dublin, by precipitating a solution of tartar emetic by means of carbonate of ammonia.

Diaphoretic Antimony. Syn. *White oxide of antimony* of the French Codex. We have already stated that this preparation, more properly called *washed diaphoretic antimony*, is considered to be a superantimoniate of potassa; but it may be doubted whether an equal weight of nitre, as directed in the Codex formula, is sufficient to convert the whole of the antimony into antimonic acid. Even when a larger proportion of nitre is employed, BERZELIUS states that the washed product contains superantimonite, as well as superantimo-

niate of potassa. M. PÉTROZ, who analyzed this preparation at the request of LAENNEC, also found it to contain antimonite of potassa, this salt being present to the extent of about half its weight; but the different samples, which he subjected to analysis, were found to differ materially in composition.

M. RAYER reports that diaphoretic antimony introduced into the cellular tissue of rabbits, produced no particular effect. Given in doses of two or three drachms to pneumonic patients, it caused no perceptible derangement of the digestive functions. LAENNEC has carried the dose rapidly, in pneumonia, to four or five drachms, without producing any decided effect. M. RAYER states, as the result of his experience, that, notwithstanding its name, this preparation, of all the antimonials possessing any activity, is least disposed to act as a sudorific. From these facts, therefore, it may be fairly inferred that diaphoretic antimony is a weak and variable preparation, and should be banished from practice. The name given to it in the French Codex is altogether incorrect.

Glass of Antimony. This preparation is violently emetic and cathartic; and, from the harshness and danger attending its operation, is entirely laid aside in modern practice. In order to mitigate its effects, the early chemists roasted it with wax, whereby it was converted into the preparation called *cerated glass of antimony.* In this form, the glass is divested in part of its violence, and was formerly given in doses of three or four grains, increasing, as a cathartic and emetic. The cerated glass was praised by PRINGLE and others as a remedy in dysentery and diarrhœa; but at present it has very properly gone out of use in those diseases.

Crocus of Antimony. At present, this preparation is only used in veterinary medicine.

Antimonial Powder. Syn. *Oxide of antimony with phosphate of lime.* This powder is deemed alterative, diaphoretic, purgative, and emetic. It is given in fevers, and in inflammatory affections generally, with a view to its diaphoretic effect. At the present day, however, it is much less employed than formerly. According to Dr. CHEYNE (*Dub. Hosp. Reports*, I. 1818.) it is a useful remedy in hydrocephalic and apoplectic cases. During the existence of the precursory symptoms of apoplexy, such as sense of fullness of the head, vertigo, indistinct vision, tinnitus aurium, &c., he was in the habit of resorting to the long-continued use of antimonial powder, in doses of two grains at bed-time, gradually increased until a sensible effect was produced on the stomach, bowels, and skin. Combined with calomel and guaiac, it is sometimes given in cutaneous diseases, and with calomel, camphor, and opium, in acute rheumatism. The addition of a little rhubarb to the powder, renders it, according to Dr. CHEYNE, less apt to excite nausea.

The utmost diversity of opinion exists among practitioners as to the remedial value of antimonial powder. The late Dr. DUNCAN characterized it, in whatever way prepared, as "one of the best antimonials we possess." Dr. A. T. THOMSON places no confidence in its diaphoretic powers, and believes that "every object for which antimonial powder can be prescribed is more certainly obtained from the employment of small doses of tartarized antimony." Dr. BARKER of Dublin is of opinion that more efficacy has been attributed to it than it deserves. Many other practitioners deny the remedial activity of this powder, and not a few contend that it is absolutely inert.

Antimonial powder, on account of its insolubility, must be given either in powder or pill. The ordinary dose with a view to produce diaphoresis, is from three to eight grains, repeated every third or fourth hour, and assisted by free dilution employed in the intervals. In larger doses, it operates as a purgative and emetic. It is remarkable, however, to what an extent this preparation can be given, in some instances, without producing any effect. Mr. HAWKINS gave it in drachm doses morning and evening, without any obvious impression; and even Dr. DUNCAN admits that he has given it in scruple and half-drachm doses, repeated several times a day, without inducing vomiting or purging. Dr. ELLIOTSON relates cases in which he gave from half a drachm to a drachm with little or no effect. (*Medico-Chir. Trans.* XIII. 233.)

Taking into view the conflicting statements of equally respectable practitioners, we are forced to admit that the substance, called antimonial powder, is occasionally active and occasionally inert. The bare fact of the great inequality of its operation, under apparently the same circumstances, is a sufficient objection to its employment; for whether the inequality depends upon the presence or absence of acid in the stomach, its variable composition, or both, still the objection to its use is valid. If it should be found on further observation, that the different states of the

stomach as to acidity is the principal cause of its diversified effects, then we should entertain but little hope of its ever being rendered a safe and valuable remedy; but if its unequal operation should prove to depend upon its variable composition, the task will belong to the future pharmaceutist to devise some precise mode of preparing it, so as to produce a uniform preparation, corresponding with the active form of the antimonial powder as now in use.

It may not be deemed an unreasonable conjecture, that, notwithstanding the labours of physicians and chemists, the antimonial powder, though intended as a substitute for James's powder, is by no means identical with it. The proprietor of that nostrum, no doubt, intended to deceive the public by the complicated receipt, which he deposited in the British Chancery, in order to obtain his patent, and therefore, no dependence can be placed on it. But when we compare certain analyses of James's powder with those of antimonial powder, we find considerable differences; as, for example, the presence in the former of potassa, which could not be an ingredient in the latter. Thus M. Pully, an Italian chemist, has analyzed what he alleges to be the true James's powder, in which he found antimonic acid 7, phosphate of lime 4, sulphate of potassa 4.5, free potassa, holding protoxide of antimony, 3.5—Total 19. (*Ann. de Chimie*, LV. 77. An 1804.) Dr. Barker supposes that the powder analyzed by M. Pully, though probably made by roasting the materials according to the specification of Dr. James's patent, was not subjected to washing. He is of this opinion, because some samples of genuine James's powder which he examined, contained scarcely a trace of adhering sulphate of potassa. (See James's *Powder*.)

§ IV. Toxicological Effects, and Tests. Of all the antimonial preparations, butter of antimony and tartar emetic are the only ones which can be properly ranked as poisons. The former, however, as already explained, acts as a caustic, and is not likely to be swallowed; and, therefore, it would be of no practical importance to treat of its poisonous properties. We shall, accordingly, confine our remarks under this head exclusively to tartar emetic.

Symptoms caused by a poisonous dose of tartar emetic. Tartar emetic, when taken in a poisonous dose (twenty grains and upwards), causes, in different cases, excessive vomiting, spasmodic contraction of the pharynx and œsophagus, difficulty of swallowing, hiccup, ardent thirst, burning at the stomach, sharp pains in the stomach and bowels, bilious, frothy, and bloody stools, tenesmus, suppression of urine, tendency to syncope, syncope, prostration, intermission, inequality, and contraction of the pulse, coldness of the skin, sometimes intense heat, difficulty of respiration, vertigo, loss of sense, convulsive movements, very painful cramps of the limbs, &c. &c. Cases in which it has been taken to a sufficient extent by man to cause death are rare; for, in consequence of the occurrence of vomiting, the poison seldom remains long enough in the stomach to produce fatal effects. The influence of vomiting is strikingly shown by the fact that Magendie found that dogs could sometimes take *half an ounce* of tartar emetic with impunity, if allowed to vomit; but that if the gullet was tied, from *four to eight grains* would kill them in a few hours.

Post-mortem appearances. According to the experiments of Magendie on inferior animals, the lesions produced by tartar emetic consist principally in inflammation, more or less extensive, of the lungs, and of the mucous membrane of the alimentary canal. The post-mortem appearances observed by Rayer in his experiments, were generally the same as those recorded by Magendie, with the exception that he found no lesion of the lungs. (See p. 54.) When death occurs quickly, as for example, in twenty-five minutes, from tartar emetic applied to a wound, no trace of inflammation is sometimes discoverable in any of the organs. This fact is important in medico-legal investigations.

Dr. Charles A. Lee, in the New-York Medical and Physical Journal for 1829, has reported a case of death from tartar emetic, in a child of a few weeks old, who had swallowed about fifteen grains of the emetic salt. On dissection, the mucous coat of the stomach was found red and softened. Held up to the light, it was of a bright crimson colour. The stomach contained a small portion of slimy mucus, which appeared to consist of the mucous membrane softened. The duodenum was of a deep-brown colour, almost livid, and contained the same kind of substance as the stomach. The inflammation extended no further than the colon. The vessels of the scalp, as well as of the brain, were full of blood, showing a preternatural determination to the head. The ventricles were half-filled with water, and there was

effusion between the pia mater and arachnoid membranes. The right side of the heart was distended with blood.

Under the head of the post-mortem appearances after the use of tartar emetic, it may be proper to mention that M. GUERARD, in the Revue Méd. for Aug. 1831, reports two instances in which this substance, taken in large doses, produced pustules similar to those caused by its application to the skin, and occupying a considerable portion of the intestinal canal. In these cases the stomach was healthy, and the intestines exhibited no sign of dothinenteritis.

Treatment. The treatment of poisoning by tartar emetic is very simple. If vomiting has not occurred before the physician arrives, it should be induced, if possible, by tickling the throat, and causing the patient to swallow large draughts of warm water. The administration of large quantities of sweet oil will sometimes favour vomiting, and may prove useful. While these measures are being pursued, a strong decoction of Peruvian bark, or of some other astringent vegetable, should be prepared and given freely to the patient. Until the decoction is ready, it will be proper to give the bark in powder, stirred up with water. If the bark be not at hand, the interval consumed in procuring it should be occupied by administering plentifully a strong decoction of common tea. These different vegetables act as antidotes in consequence of their containing tannin, which decomposes the poison, and forms with its oxide the inert tannate of antimony. According to ORFILA, alkaline sulphurets, which have been proposed as antidotes, augment the irritation. When the patient has vomited enough, and taken a sufficient quantity of bark; laudanum, to quiet irritation, will generally be found useful, administered either by the mouth or by injection. To combat the consecutive inflammation, bleeding, both general and local, demulcent drinks, and other soothing and antiphlogistic remedies must be resorted to.

The efficacy of cinchona as an antidote is attested by several examples of its good effects. M. SERRES relates the case of a man who swallowed half a drachm of tartar emetic, and who recovered under the use of this antidote. The symptoms produced were, burning pain in the stomach, convulsive tremors, impaired sensibility, cold clamminess of the skin, hiccup, swelling of the epigastrium, but no vomiting. Decoction of cinchona was freely given; and almost from the first moment of its administration, the patient felt relief, and began to sweat and purge. Next morning, vomiting occurred, and for several days signs of slight inflammation of the stomach existed. We may add that the danger in this case arose from the absence of vomiting; for, as a general rule, the ingestion of half a drachm of tartar emetic would not endanger the life of an adult, if free vomiting occurred. Another and more striking case is related by Dr. SAUVETON, of Lyons, in the sixth volume of the Bulletin des Sciences Médicales. A lady swallowed by mistake a solution of sixty grains of tartar emetic. She was seen in ten minutes by her physician, and at that time, vomiting had not taken place. Tincture of bark was immediately given in large doses, and the lady recovered, without having experienced any unpleasant symptoms, except nausea and slight colic.

Tests for Tartar Emetic. Dr. TURNER, in a paper published in the Ed. Med. and Surg. Journ. XXVIII. 71, has examined with great care the effects of different reagents on a solution of this salt. The results of his experiments, as detailed by CHRISTISON, are as follows.

1. *Caustic potassa* causes a white precipitate of protoxide of antimony in a tolerably concentrated solution. The first portions of the test have no effect, as they serve merely to neutralize the excess of acid in the antimonial salt; and an excess of the test redissolves the precipitate previously thrown down.

2. *Lime-water* throws down a white precipitate, (a mixed tartrate of lime and antimony,) and acts with somewhat greater delicacy than caustic potassa. It has no effect, however, when the solution contains only half a grain to the ounce.

3. *Carbonate of potassa* (salt of tartar) acts with still greater delicacy, also throwing down a white precipitate of protoxide. It does not act, however, in solutions containing only a quarter of a grain to the ounce.

4. *Muriatic and sulphuric acids* throw down a white precipitate, and redissolve it when added in excess. A large excess of the sulphuric acid is necessary for this purpose. These tests have about the same delicacy as the carbonate of potassa. The precipitate which they throw down is a submuriate or subsulphate of antimony, mixed with cream of tartar.

5. *Infusion of galls*, when fresh and strong, causes a dirty, yellowish-white precipitate of tannate of antimony; but it is not a delicate test, as it will not act in

solutions which contain much less than two grains to the ounce.

6. *Sulphuretted hydrogen* is by far the best test for tartar emetic. In a solution containing only an eighth of a grain to the ounce, it produces an orange-red colour, which, upon expelling the excess of the gas by heat, becomes an orange-red precipitate of hydrated sesquisulphuret of antimony. In stronger solutions, the precipitate is thrown down at once. The peculiar colour of this precipitate is in general sufficient for recognizing it; but if an unwillingness should be felt to rely on this single mark, it may be further distinguished by its solubility in a solution of pure potassa, and by dissolving, with disengagement of sulphuretted hydrogen, in hot muriatic acid, forming a solution from which a white curdy precipitate (powder of Algaroth) is thrown down by water. It is readily distinguished from the sulphuret of arsenic, which is very soluble, with loss of colour, in liquid ammonia; while the antimonial sulphuret is but sparingly soluble in the same alkali, without decoloration.

In medico-legal investigations arising out of cases in which poisoning is suspected to have been produced by tartar emetic, the salt will exist either in the solid state, or mixed with organic substances, such as half-digested food, &c., as existing in the stomach. In the solid state, tartar emetic, upon being subjected to heat, decrepitates, gives off white fumes, and then chars. If the heat be increased, the oxide of antimony is reduced by the carbonaceous matter, and little metallic globules, resembling mercury in colour, will be found disseminated through the mass. According to Dr. Christison, the best way to reduce tartar emetic is to char it in a porcelain vessel, or watch-glass, and then to increase the heat till the charred mass takes fire. This method, however, is applicable to those cases only in which a considerable portion of the emetic salt is at the command of the experimenter.

When the tartar emetic is mixed with alimentary liquids, by which it is partially or not at all decomposed, it is merely necessary, according to Orfila, to subject the suspected liquid, after filtration, to the action of the appropriate tests for tartar emetic, but especially to a current of sulphuretted hydrogen, in order to decide on the presence of the poisonous salt. If, however, it has been entirely decomposed by the alimentary matters with which it may have come in contact, he recommends that the suspected matter should be dried with charcoal and potassa, and then calcined in a crucible, in order to bring the antimony to the metallic state. Sometimes, however, he very correctly remarks, the quantity of tartar emetic present is so small, as not easily to admit of being detected by this process. In this case, he advises that the product of the calcination be dissolved in dilute aqua regia, which will have the effect of oxidizing and dissolving the antimony; and that the solution obtained, after having been freed from excess of acid by evaporation and filtered, be precipitated by a stream of sulphuretted hydrogen, in order to bring the antimony to the state of sesquisulphuret.

For detecting tartar emetic when mixed with organic substances, Dr. Turner has proposed the following method, which, with Dr. Christison, we greatly prefer to that of Orfila. The substances are first digested in water, acidulated with a little muriatic and tartaric acids; the former acid to coagulate some organic matters, the latter, to give complete solubility to the antimony. This property of tartaric acid depends upon the fact, ascertained by Dr. Turner, that this acid dissolves all precipitates whatsoever, formed by reagents with tartar emetic, except that caused by sulphuretted hydrogen. The solution obtained, after having been filtered, is subjected to a stream of sulphuretted hydrogen, "when the orange-red sesquisulphuret of antimony subsides, which preserves its characteristic tint even when deposited from coloured solutions. It may then be further recognized by solution in hot muriatic acid, and precipitation by water."

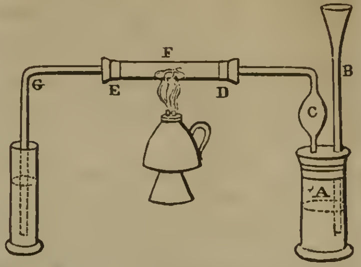
Thus it appears that Orfila, Christison, and Turner, among the best authorities extant as toxicologists and chemists, agree in considering sulphuretted hydrogen as the best test for tartar emetic in solution. They also coincide in viewing the precipitate which it produces (the sesquisulphuret) as the most eligible substance to be submitted to the process of reduction, in order to obtain the antimony in the metallic state.

In giving evidence on trials, the medical jurist should not be content to rest his statements solely on the indications of the liquid tests. The evidence furnished by these tests is, indeed, often very satisfactory, but still incomplete. To render it complete, it is necessary that the poison should be brought to the metallic state. Hence it is that the mode of conducting the process of reduction is of such great importance.

Orfila recommends that the reduction be conducted as follows:—If the quantity of sulphuret amounts to several grains, mix it with charcoal and potassa (black flux), and heat it to redness in a Hessian crucible. The combined action of the alkali and carbonaceous matter will bring the sulphuret to the metallic state. If, however, the operator has at his command a very small portion only of the sulphuret, the use of the crucible must be dispensed with, and the following process of reduction substituted. Heat the matter mixed with black flux, in a small glass tube, by means of a lamp with four wicks, aided by the blowpipe.

Dr. Turner is of opinion that the above processes of reduction by the aid of black flux are very precarious, and recommends as preferable the following process, which is sanctioned by the approbation of Dr. Christison. Place the dry sulphuret in a tube, transmit through it a current of hydrogen, and as soon as the atmospheric air has been displaced, so as to prevent an explosion, heat the sulphuret by the flame of a spirit-lamp. The decomposition of the sulphuret commences at a temperature by no means elevated; but to complete it and fuse the antimony, the glass should be made red-hot, and kept at that heat for five or six minutes. "The sulphur is carried off in the form of sulphuretted hydrogen, and the metallic antimony, recognizable by its lustre, remains. The metal is principally found where the sulphuret lay; but if the current of gas, during the reduction, happens to be rapid, it causes, mechanically, a spurious sublimation of antimony, which lines part of the tube with a thin film of metal. When much organic matter is mixed with the sulphuret, the metal is sometimes indistinctly seen. In that case it should be dissolved in a few drops of nitro-muriatic acid with heat, and precipitated by water: it may then be redissolved by tartaric acid, and again precipitated with its characteristic tint by sulphuretted hydrogen." (Dr. Turner. *Elements of Chemistry.* Fourth London ed. 1833. p. 566.) This process of reduction by Dr. Turner is stated by Dr. Christison to be capable of developing "antimony characteristically from only a tenth part of a grain of the sulphuret." The lustre of the metal, to be distinctly seen, may require the aid of a lens. Orfila characterizes Dr. Turner's process as a good one in the hands of the chemist, but objects to it as too difficult to be readily carried into effect by the mere physician who is not accustomed to manipulate. This objection on the part of Orfila does not strike us as being valid.

The apparatus employed by Dr. Turner, in his reduction-process above referred to, is represented in the following cut, taken from Dr. Christison's Treatise on Poisons.



A, the vessel with zinc and diluted sulphuric acid, the latter of which may be renewed by the funnel B. C, a ball on the emerging tube, to prevent the liquid thrown up by the effervescence from passing forward. D, E, corks by which C and G are fitted into F, the tube which contains the sulphuret at F. G, the exit-tube for the sulphuretted hydrogen, playing into a vessel containing a solution of acetate of lead. When the hydrogen has passed long enough to expel all the air, the spirit-lamp flame is applied at F; and when sulphuretted hydrogen is formed, the lead solution is blackened. The figure is one-sixth the size of the apparatus.

Franklin Bache.

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I. H.

ANTIPATHY. (From αντι, against, and παθος, feeling.) αντιπαθης, Gr.; *Antipathia*, Lat.; *Antipathie*, *aversion*, Fr. Involuntary aversion or repugnance, natural or acquired, to any object. To all the senses, internal as well as external, certain excitants are pleasurable and others painful; the former are the source of the *appetences* (q. v.), the latter of the *antipathies*. Every living being appears to be endowed with a love of life, and to experience a desire for those objects which tend to the preservation of their existence, and a repugnance to whatever is calculated to destroy it. This latter may be considered as a natural, instinctive antipathy. The caprices of individuals, or some associations, give rise to a number of antipathies, which, as their origin denotes, are acquired. Anomalies of sensibility—a peculiar mode of affectibility of the organism, idiosyncrasy (q. v.),—and real diseases of the organs, the instruments of the sensations, furnish not less fruitful sources of these aversions, some of which are of the most singular character.

Numerous examples of these antipathies are recorded in the annals of our science, and there are probably few practitioners whose own experience has not furnished instances of them. DEUSINGIUS is said to have known a man who could not look upon the head of a hog without fainting, and who could eat of it without disgust when the ears were removed. (*Dict. des Sc. Méd.* II. 202.). We are acquainted with a gentleman who has an antipathy to the sight of a spider, or even a picture of one; and also with a lady who has an aversion to the sight of a mouse, and this is equally the case whether the animal be alive or dead. AMATUS LUSITANUS quotes the case of a monk in whom the odour of a rose caused fainting, and who was compelled, during the season of this flower, to confine himself to his cell. (*Ibid.*) ZIMMERMANN has furnished us with the case of an individual who was always thrown into convulsions by the rustling of silk, and we ourselves knew a person who had the greatest horror of the feel of velvet. The anatomist GAVARD, it is said, could not eat apples without experiencing convulsions, which continued so long as the fruit remained in his stomach; and three individuals have come under our own observation, in whom the taste or odour of wine excited extreme nausea. The loathing experienced at the thoughts of food which has caused indigestion, is familiar to every one.

Without pretending that we should be guided by the aversions, of which pregnant women and chlorotic girls furnish so many examples, it is not the less certain that great utility may be derived, in the diagnosis and treatment of diseases, from attention to the antipathies; but it is necessary carefully to distinguish those which result from the prejudices of the patient or of his attendants, from those which are the expression of real sensations. The presence or absence of a re-

pugnance to hot drinks may serve to distinguish gastritis from ileitis; and the aversion to particular descriptions or every kind of food in certain diseases, is often the expression of a genuine sensation, the language of the suffering organs which it is the duty of the practitioner to respect.

I. HAYS.

ANTIPERIODICS. This epithet has been introduced into medical language, within a few years, by the French, to designate those therapeutic agents which possess the property of preventing the return of the paroxysms of intermittent or periodic diseases. The agents to which this property has been assigned, are exceedingly numerous. Those admitted by general consent, to enjoy it, in the highest degree, and to be most constant in their operation, are cinchona and its alkaloids. It is also possessed, though in a less degree, by all the different vegetable substances having analogous physical and physiological properties to the cinchona, and particularly characterized by great bitterness, as the barks of the dog-wood, willow, oak, &c., gentian, columba, quassia, wormwood, absinth, angustura, leaves of the holly, &c.: also by many mineral tonics and astringents, as the sub-carbonate, Prussiate, and sulphate of iron, sulphate of alumina, oxide of zinc and subnitrate of bismuth, &c., and various other agents, as the arsenical and antimonial preparations, emetics, purgatives, bleeding, epispastics, ligature to the limbs, shower-baths, strong mental emotions, &c. &c.

From the above enumeration, it must be manifest that there exists no analogy between the evident properties of these agents, some of which indeed are characterized by entirely opposite qualities, and the circumstances under which they prove effectual, are, moreover, infinitely varied; hence it is not in any common property that we are to seek for an explanation of their modus operandi. This must be derived from a knowledge of the nature of periodic diseases and of the modifications in the organism induced by their remedies, questions which this is not the place to discuss; and we must therefore refer to the articles *Periodicity*, *Intermittent fever*, *Cinchona*, &c., where they will be fully considered. It may be expected, however, that we should briefly state in this place the general conclusions on this subject, and we shall accordingly attempt the task.

The attraction to itself, by some organ or tissue, the seat of irritation—the concentration on it—of an undue portion of the sanguine fluid, is an essential element of the paroxysm of all intermittent diseases, as of all irritations. The prevention of the occurrence of this congestion is then to ward off the access of the paroxysm. This, it appears to us, may be accomplished in three ways; 1. by those agents which cause a sedation in the organ or tissue the seat of the irritation, and thus destroy the moving power productive of the afflux; 2. by those which divert the current to some distant part, by exciting either another and temporary irritation or by giving a centrifugal direction to the circulation; and 3. by those remedies which excite the general capillary circulation, or, as suggested by our ingenious colleague, Dr. JACKSON, which "impart force and stability to the actions of the capillary and parenchymatous structure and circulation;" thus enabling them to refuse to yield their fluids at the demand of the irritated tissue. The agents which act in the first mode are the narcotics, cold, local depletion, &c.; in the second, epispastics, purgatives, ligatures to the limbs, emetics, &c.; and in the third, cinchona and its congeners, the mineral tonics, &c.

I. HAYS.

ANTIPHLOGISTICS. (From αντι, against, and φλεγω, I burn.) In its strict etymological meaning, this term designates those means directly calculated to repress and abate inflammation. It is, however, very frequently employed in a more extended meaning. It is applied often to all the means that enter into the *treatment* of inflammations. But the treatment for inflammation may be, and in reality is, exceedingly diversified, and consists of the production of varied and even opposite phenomena. Depletion, emollients, sedatives, stimulant and exciting evacuants, and revulsives, are all brought into operation. Because the cure of inflammation is the consequence of this combined action of different agents, they must not therefore all be characterized by the same general term. The language of science should be precise, and names should, as much as possible, be expressive of positive phenomena or characters. The term antiphlogistics should then be restricted to those agents whose immediate and direct action on a living tissue, is to allay or abate its vital activity and reaction; to diminish the force of its vital phenomena, and thus oppose those conditions essential to the existence of the phenomena of inflammation. The remedies possessing these characters and properties are,

1. Sanguine depletion, both general and topical, when duly employed and properly applied;

2. The classes of demulcents, emollients, temperants, with cooling aqueous drinks;

3. Baths, general or local, fomentations, and poultices;

4. Cold, adapted in its degree to the animal temperature and force of vital activity;

5. An exact, mild, and limited diet, from which are excluded all stimulant, exciting and heating articles of food and drink. It is often named antiphlogistic diet or regimen.

The whole combined together form the antiphlogistic treatment.

Emetics, purgatives, and other evacuants have been placed amongst the antiphlogistics. Nothing can be more erroneous. Their positive and direct action is the opposite of that produced by the antiphlogistics, and it is only secondarily that they exert such an influence. They first excite the tissue on which they act, as a consequence of which secretion ensues. But, if this does not occur, as often happens, a phlogosis or inflammation then results or is aggravated if previously existing from the intensity of their unrelieved irritation. (See *Inflammation.*)

S. Jackson.

ANTIRRHINUM. Snap-Dragon, Toad-Flax. *Linaire*, Fr.

Sex. Syst. Didynamia angiospermia. *Nat. Ord.* Scrophularineæ.

Gen. Ch. *Calyx* five-parted; the lower segments remote. *Corolla* calcarate, ringent, orifice closed by the prominent palate. *Capsules* ovate, two-celled, two-valved, bursting at the summit with three to five reflected dentures, a stapediform, styliferous arch remaining between either aperture. Gœrtner.

Almost all the species of plants belonging to the natural order Scrophularineæ are possessed of somewhat similar properties, being acrid and poisonous, which qualities are strongly developed in the genus under consideration, several species of which are common in the United States. It should be noticed that by the late improvements in botany all the species with a calcarate corolla have been formed into a separate genus under the name of Linaria. The most common and most generally used of these plants, is the

A. linaria. [Linaria vulgaris.] Toad-Flax, Ransted-Weed, &c. *Linaire*, Fr.; *Leinkraut*, Germ. *Sp. Ch.* Stem erect; leaves linear-lanceolate, scattered. crowded, spikes terminal; flowers imbricate; calyx smooth, shorter than the spur. Beck.

This well-known plant, which is by far too abundantly found in all parts of the United States, is not indigenous, though it appears to have been introduced at a very early period after the first settlement. It is usually found in barren fields, pastures and road-sides, where its yellow flowers are very conspicuous from July to September. It is perennial and extremely difficult to eradicate. It has a strong unpleasant virous smell, somewhat resembling that of the narcotic plants. Its taste is rather bitter and nauseous. At one time, it was in high repute as a purgative, but more especially as a diuretic, and the older writers on the materia medica appear to have had the greatest confidence in its powers, to fulfil not only those indications but many others. At the present day, however, it is seldom used except as an external application, particularly in the treatment of hemorrhoidal tumours; of its efficacy for this purpose, there is ample testimony [Haller, Curtis, &c.]; and from our own experience of its good effects in the relief of the pain and irritation attendant on this complaint, we are inclined to think highly of its powers. The part used is the expressed juice, which may be employed either as a fomentation, or mixed with a cataplasm. It is also made into an ointment, which has attained some celebrity in domestic practice not only in the cure of hemorrhoids, but also in tetter and other diseases of the skin.

The *A. cymbalaria*, ivy-leaved toad-flax, which is a native of Europe, and, according to Dr. Hamilton, is also found in India, has been employed in medicine as a vulnerary. Merat and De Lens are of opinion that it does not possess the acrid and poisonous properties of the *A. lindria*, but is allied in its therapeutic effects to the antiscorbutic vegetables. Dr. Hamilton states that he was informed by a Hindoo physician, that the dry plant was given in India in combination with sugar twice daily in diabetes.

The seeds of another species, the *A. majus* or greater snap-dragon, furnish a large proportion of a bland oil, which forms an excellent substitute for that of the olive.

R. E. Griffith.

ANTISCORBUTIC. (From *anti*, against, and *scorbutus*, scurvy.) Under this term is strictly included every measure suitable to the cure of scurvy; but formerly it was especially applied to the cruciferous and alliaceous plants, because

they were believed to possess specific virtues against the disease. This last application of the term is, however, exceedingly objectionable, since these plants are not only far from being the only remedies for the complaint, but they are in many cases utterly useless and even contraindicated. In the article *Scurvy* the therapeutic agents which have attained reputation as antiscorbutics will naturally present themselves for consideration, and to avoid repetition we will merely refer to that article. I. H.

ANTISEPTIC. (From αντι, against, and σηπτος, putrid.) According to its etymology and in its most extensive signification, this term is applicable to every means capable of preventing putrefaction either in dead or living organic matter. The putrefaction of dead matter is hindered by various physical agents which defend it from the action of influences favourable to its decomposition; but as a consideration of them cannot be conveniently separated from the examination of the changes which take place during the putrefactive process and of the conditions which favour those changes, we must refer for an exposition of this subject to the articles *Putrefaction* and *Gangrene*. There is, however, a more restricted signification in which the term antiseptic has been used, and which appears to demand a brief explanation here.

During the reign of the humoral pathology, various diseases were ascribed to a general putrescency or septic state of the fluids and solids; and the remedies supposed to be curative of this condition were termed antiseptics. With the downfall of humoralism, the belief in the existence of such a state was abandoned, and the term antiseptic in this sense was banished from the vocabulary of the solidists. But there is probably no hypothesis, however absurd, which does not contain at least some portion of truth; and humoralism, with all its extravagances and fictions, embraced propositions not wholly destitute of foundation, and which ought not to be allowed to perish in the ruins of the doctrine. That a general putrescency of the living organism can take place, has unquestionably never been proved, and therefore, in sound philosophy, cannot be admitted; but that in certain diseases the vitality of the solids and fluids is diminished—that there exists in these parts, if not a tendency to putrefaction, at least a diminished ability to resist the influence of physical laws tending to their decomposition, can scarcely be denied; and the remedies employed for the removal of this condition seem justly entitled to the epithet antiseptic.

If any portion of the apparatus of hematosis be incapable of performing its functions, the blood cannot be perfectly elaborated, and must be deficient in some of its constituents. Will not then its vital force, as well as that of the solids formed from it, be lessened, and their ability to resist the influence of chemical laws be equally diminished?

The alimentary canal sometimes has its vital forces so depressed, as to lose, to a great extent, its power over its contents, which putrefy, and the most fetid gases and products are generated. Does not the contact of these products with the intestinal mucous membrane, and still more their absorption or imbibition into the system, aggravate extremely the existing or create new disorder?

If these questions be solved in the affirmative, it would seem to follow that the solidists have been too exclusive in abolishing from the materia medica the class antiseptics. The agents adapted to the relief of the conditions of the organism adverted to, are not only those agents which directly excite the vital energy, as stimulants and tonics, but others which equally deserve the title of antiseptic, as the acids and some of their salts, the chlorides, creosote, &c., though their precise mode of action is not so well determined. To us it seems probable that these last produce their beneficial effects sometimes by furnishing to the organism certain of its elements which are deficient, in consequence of the incompetency to perform their functions, of one or more of the proper organs of supply; at others, by preventing the decomposition of foreign matters within the organism, &c. Be their modus operandi, however, what it may, the utility of these agents is sanctioned, by their being administered, at times, even by those who are most vehement in their denunciations of the possibility of the existence of a septic state in the economy. M. Chomel appears to rely principally upon chloride of lime or soda in the treatment of some of the low forms of typhus fever. Dr. Stevens has adduced strong testimony to the efficacy of the neutral salts in malignant yellow fever, and various facts recently observed hold out the belief that advantage may be derived from creosote in some of the cases we have been considering. That the acids are often

productive of the best effects in the depressed states of the system connected with scurvy, is universally conceded.

The precise indications which these agents are capable of fulfilling, and the circumstances which should guide us in their administration, will be more properly considered in the special articles on these agents and on the diseases in which they are employed. Our only object at present is to throw out a few hints, in the hope of exciting attention to the subject; as we are fully convinced that an investigation will lead to useful results. At the same time that we admit the solidists have been too exclusive in their views, we must be permitted to disclaim all adhesion to the old humoral pathology—a doctrine too monstrous and absurd, in its details, to be for a moment entertained by any one whose mind is not utterly benighted. I. HAYS.

ANTISPASMODICS. (From αντι, against, and σπασμα, spasm.) Medicines calculated to relieve or prevent spasm. They operate either by removing the cause of the affection, or by producing in the nervous system an action or condition incompatible with that which they are intended to supplant. As the causes of spasm are various, and its character exceedingly protean, the remedies are numerous, and without any such community of sensible or physiological properties as might entitle them to the rank of a distinct class of medicines. A rapid view of the means which may be employed, under various circumstances, for the production of an antispasmodic effect, will afford ample evidence of the correctness of this statement.

The remedies addressed to the cause of the complaint, must obviously vary with the cause. When the spasm, as is probably the case in most instances, depends upon inflammation or an irritation approaching to inflammation, at the origin or in the course of the nerves which supply the affected muscles, or in the muscles themselves, it is plain that antiphlogistic measures will be the most efficient. Hence general and local bleeding, cathartics, external revulsives, and low diet, are often excellent antispasmodics. But involuntary muscular contractions often originate in a state of debility, and are relieved by means calculated to impart vigour to the system. Under these circumstances, the diffusible stimulants and tonics are the best antispasmodics, the former being applicable to cases of considerable and sudden debility, the latter to those of longer continuance and less prostration.

Of the remedies which relieve spasm by acting directly upon the nervous system, some produce the effect by diminishing the susceptibility of the nerves, and thus rendering them insensible to those impressions which ordinarily throw them into more or less violent commotion. In this way, in part at least, narcotic medicines act as antispasmodics. Others operate by changing the direction or character of the morbid nervous action. Whatever tends to induce and sustain a flow of nervous energy to organs remote from the part affected, may relieve spasm. The remedies capable of producing this effect scarcely admit of enumeration; as there is not a substance having any medicinal power, unless it be purely sedative, which may not be made to exalt the nervous action of some particular organ or system of organs, and thus to draw off irritation from some other part in which it may exist. It is probably in this way that emetics and nauseating substances often prove so efficacious in the relaxation of spasm, relieving distant organs by concentrating irritation in the stomach. But there are also medicines which prove antispasmodic by a peculiar influence over the nervous system, wholly independent of any narcotic power, and not explicable upon the mere principle of revulsion. The mode in which such medicines operate cannot be precisely understood, so long as we are ignorant of the nature of nervous action. We see, however, effects produced by many of them so analogous as to entitle them to be classified together, and so different as a whole from the effects of other medicines as to justify their arrangement into a distinct group. As, among these effects, the relaxation of spasm is perhaps the most prominent, and that for which the medicines are most frequently prescribed, the class has in many treatises on Materia Medica received the name of antispasmodics; and it is to these that the term is usually restricted in ordinary medical language. By an antispasmodic, therefore, in this sense, is not meant any medicine which is capable of relaxing involuntary and unhealthy muscular contraction, but merely an individual of a certain class of medicines, among the effects of which the relief of spasmodic action is one of the most observable and important.

From what has been said, it will be perceived, that the simple power of relieving spasm cannot serve as the basis of a distinct class of medicines; but that a natural group exists, possessing this among

other powers, to which the name of antispasmodics has by many authors been exclusively applied as the most convenient. The nomenclature is unfortunate, as it is founded upon an effect resulting from a great variety of remedies besides those included in the class, and may therefore lead to erroneous notions. The term *nervine* might perhaps be considered more appropriate; as it expresses the main peculiarity of the medicines, namely, their preferable direction to the general nervous system, without any strong tendency, as in the instance of the narcotics, to operate especially upon the brain. To this distinct class of antispasmodics, the remainder of the observations, under the present head, will be confined.

These medicines, for the most part, have a strong and disagreeable odour and taste, and owe their virtues to a volatile principle. In their operation upon the system, they excite, to a greater or less extent, the heart and arteries, increase animal heat, promote usually one or more of the secretions, and exalt the nervous energy in general, without necessarily producing, either as a primary or secondary effect, intoxication, delirium, or stupor. As remedies, they not only allay spasm, but are useful also in other disordered operations of the nervous system, and are frequently given to cheer the languid or depressed spirits, to quiet restlessness, to relieve morbid vigilance, and to calm those diversified nervous irregularities which are grouped together under the name of hysteria. Their particular therapeutical application will be treated of under the head of the several substances individually which compose the class. It may be proper, however, in the present place, to observe, that caution is always necessary in their use, when the nervous affection depends upon or is complicated with acute local inflammation, or a plethoric state of the system.

The antispasmodics most employed are musk and castor from the animal kingdom; assafetida and other fetid gum resins, garlic, and valerian, from the vegetable kingdom; and the oil of amber, and certain ethereal and ammoniacal preparations, the products of chemical processes. The *Symplocarpus fœtidus* has also antispasmodic properties; and the empyreumatic oils resulting from the destructive distillation of animal substances, together with various bituminous liquids, have been supposed to be similarly endowed, though at present discarded from practice. Several of the narcotics add proper antispasmodic powers to those by which they are characterized as a class; and are often effectual in relieving spasm and other nervous disorders, in doses insufficient to produce their narcotic effects. Such is particularly the case with camphor and opium. Some of the medicines usually ranked among the tonics appear to exercise an influence over the nervous system, which renders them highly useful in certain chronic spasmodic and nervous disorders, in which there is no reason to believe that the complaint is connected with debility, and in which, therefore, their action is independent of the mere tonic power. Examples of this kind we have in Peruvian bark, and the various metallic preparations employed in the treatment of neuralgic and spasmodic affections. These seem to bear to the more exciting antispasmodics the same relation that the pure tonics bear to the simple diffusible stimulants. They superadd a peculiar influence upon the animal functions to that which they exercise upon the organic life, and thus become susceptible of an extent of useful application far beyond that of the tonics in which these powers are not conjoined. GEO. B. WOOD.

ANTITHENAR. (From αντι, against, and θεναρ, the palm of the hand or foot.) A name given by RIOLAN and WINSLOW to a portion of the short flexor of the thumb, and to a part of the oblique abductor of the great toe. I. H.

ANTITRAGUS. (From αντι, against, and τραγος, the tragus.) A small, flattened, conical eminence, situated posteriorly and opposite to the tragus, and below the antihelix. I. H.

ANTRUM. (From αντρον, a cavern.) This term is applied to certain cavities in the bones.

Antrum Highmorianum, the Maxillary Sinus (q. v.). I. H.

ANUS. This term is applied to the outlet or passage by which the fæces are discharged from the body. Properly speaking, it is not a simple opening, but rather a short canal formed by the termination of the internal integument of the rectum and a portion of the skin, inverted and rendered continuous with the intestinal mucous membrane. It is provided, moreover, with certain muscles especially intended to control it, and it gives attachment to several others which exercise more or less influence over its motions.

ART. I. ANATOMY OF THE ANUS. The anus is situated on the median line of the body, about an inch before and below the point of the os coccygs. When examined

externally, and at rest, it presents the appearance of an oval or linear slit, its long diameter being in the antero-posterior direction, and its sides in contact; but when distended by the passage of fæces or other solid bodies, it becomes circular. The direction of the canal of the anus is from without; inward, upward and forward: its extent is generally about an inch and a half, from the surface of the body toward the spot where the last curve of the rectum loses its close attachment to the prostate gland. This canal is formed by the action of two muscles called the sphinctores ani. Were it not for the presence of these muscles, the rectum would retain a calibre approaching to its mean diameter, until united to the external integuments. The aspect of the anus renders this fact sufficiently obvious, for the sphinctores ani gather the mucous membrane into longitudinal folds, or columns, and the neighbouring skin, into radiated plaits, which extend to a considerable distance into the intestine and on to the surface. This superabundance of integument, about, and within the anus, permits all necessary distension to take place without any great danger of laceration, but this accident does occasionally happen notwithstanding the care with which nature has guarded the part.

a. *Of the Integuments of the Anus.* The junction of the skin with the mucous membrane in the anus does not take place suddenly. Even before we arrive at the orifice, the colour has become changed to a yellow or brownish hue, much more remarkable in the adult than in the child; and it is bathed by a peculiar unctuous discharge from numerous follicles. After puberty, especially in the male, it becomes surrounded with numerous long hairs, which are not without their share of importance both in health and disease. After entering the anus, the skin changes its character, gradually and insensibly, so that it has been thought impossible to say where the cutis terminates, and where the mucous membrane begins. According to M. Cruveilhier, the cuticle extends to some distance above the anus, and terminates in an irregular festoon; an arrangement which we sometimes see most evidently, at the œsophageal end of the stomach. (*Dict. Pratique.* Art. *Anus.*)

The radiated plaits, just mentioned, produce considerable irregularities of surface, which become more and more conspicuous as they approach the verge of the anus; and within the canal, these irregularities are often rendered still more remarkable, by several elevations and depressions, to be described hereafter, and also by the enlargement of the neighbouring veins, the deposition of effused matters beneath the skin, or other slight morbid changes; some traces of which are visible perhaps in the majority of adults. This unevenness of surface gives rise to inconvenience, or disease, when strict cleanliness is neglected, by permitting the local accumulation of fæcal matter, or altered secretions; and in some cases it furnishes a lodgment for entozoary animals.

The mucous membrane of the rectum is very redundant in every direction until it approaches the anus. It is sometimes thrown into irregular wrinkles, principally ranged transversely, and sometimes into strongly marked ridges running round a considerable portion of the circumference, simulating the valvulæ conniventes of the small intestine. Occasionally, the rectum is encroached upon by transverse partitions, reaching, in extreme cases, across one third of its calibre, or even more, and dividing it into a series of very large cells resembling those of the colon, except in the fact that none of the coats of the rectum except the tegumentary membrane enter into the formation of the partitions. (Vide *Rectum.*)

But when the intestine displays itself, to form its terminal pouch, just above the commencement of the anal canal, the redundance of the mucous coat becomes less obvious in the longitudinal, and much more so in the circular direction. The longitudinal duplicatures are not so irregular or numerous as the radiated folds of the external integuments. They are called the columns of the rectum (see fig. 2. A, A, &c. p. 83.), and their number and position seem to be in great measure determined by a peculiar arrangement of the longitudinal muscular fibres of the intestine, which will be described hereafter. There are from four to ten, or more, of these columns, of unequal dimensions; and when the number is considerable, some of them are generally rudimentary. (See *fig.* 2. B, B. p. 83.). They enter the canal of the anus, diminish in size as they proceed downwards, and terminate rather suddenly very near the level of the lower edge of the internal sphincter, at the spot where it produces its strongest contraction. (See *fig.* 1. E. p. 81.). They throw the surface of the superior part of the anal canal into a series of longitudinal ridges and sulci, which have certain physiological and pathological relations, to be noticed hereafter. Some other important remarks

on the distribution of the integuments of the anus will be better understood if treated in connexion with the muscular fibres that control the actions of the part.

The skin around the anus is separated from the muscular parts beneath, by an abundance of fatty cellular tissue; but at, and within the verge, it is much more closely adherent. The mucous membrane immediately above the anus, adheres very slightly to the muscular coat of the rectum, their connexion being effected by means of very lax cellular tissue. In strong efforts to discharge the fæces, this membrane is frequently rolled out before the escaping mass, so as to form a ring or scroll around the outlet, which disappears when the efforts have ceased. In persons of costive habit, the frequent repetition of this accident, increases the liability to its recurrence, and enlarges the size of the scroll, until it becomes obvious at every stool, and may materially embarrass the discharge.

b. *Of the Muscles of the Anus.* There are two muscles proper to the anus, one common to this part and other pelvic viscera, and several others which produce more or less impression upon the position of the outlet; they will be more fully described under the head of *Perineum* (q. v.). It is proper, however, to make a few remarks upon the three first of these muscles, in the present article, and also to describe the action of the longitudinal fibres of the rectum upon the mucous membrane.

The *Internal Sphincter* of the anus (*fig.* 1 and 2. C.) is composed of a band of circular or arched fibres, forming part of the corresponding plane of the muscular coat of the rectum. It is situated immediately below the terminal pouch of that viscus, after it leaves the level of the prostate gland, and it surrounds the upper part of the canal of the anus. It varies from half an inch to an inch and a half in breadth; it is thin at its superior edge where it is amalgamated with the muscular plane just mentioned (*fig.* 1. L.), but becomes more distinct as it descends, until it reaches its lower edge, where it is strong and well marked. This muscle forms a small ring, slightly oval, which does not close the extremity of the rectum firmly and accurately, except perhaps near its lower edge. Internally it is separated from the mucous coat by the hemorrhoidal plexus of veins, some branches of which traverse the substance of the muscle.

The *External Sphincter* (*fig.* 1 and 2. F.) is much larger and stronger than the last named muscle. It occupies nearly one half the interval between the tuberosities of the ischia, and has considerable thickness. In general form, it resembles an oval ring, somewhat acuminated at the extremities of its long diameter, which lies in the antero-posterior direction. The outlet of the anus is found in the centre of this muscle, of which the fibres are parted into two distinct columns behind, and are again reunited in front, in such a manner as to produce the elongated shape of the outlet. The sphincter externus originates in a point, from the cellulo-fibrous matter about the extremity of the os coccygis. In front of this bone its fibres decussate each other at the median line, as far forward as the posterior extremity of the outlet of the anus. From these sources, the fibres diverge, in two columns, pursuing a cycloidal curve around the outlet, and reuniting on the median line in front of the anus, from its anterior extremity, to the spot where the various perineal muscles are united to each other. The outer fibres have there an acuminated insertion, extending as far forward as the bulb of the urethra. In the female, this muscle is continuous with the sphincter vaginæ. For further details as to the external attachments of this muscle, see the article *Perineum.*

The sphincter externus is separated from the skin of the perineum by a thick layer of fatty cellular tissue, which also penetrates occasionally between its fibres; but within the verge, this layer becomes quite thin, and much less adipose. The lower surface of the muscle is broad and flat. Its superior fibres rise above the inferior edge of the internal sphincter, which they embrace, and with which they are sometimes intermingled to a slight degree. The inferior fibres are considerably below the edge just mentioned, and the point of greatest contraction is near the lower surface (*fig.* 1. G.).

Between the two spots where the internal and external sphincters produce their strongest contractions, there is an enlargement of the canal of the anus, very slight, it is true, but highly important in its relations to the history of anal disease.

The termination of the plane of arched muscular fibres forming one layer of the muscular coat of the rectum, and constituting that better developed band known as the internal sphincter, forms a small funnel-like cavity, with its superior or broad opening looking upward, toward the prostate gland and the bas-fond of the bladder, and its lower part, or neck, nearly or quite closed by the lower edge of the sphincter. This funnel forms one half or more of the canal of the anus, and may

vary in length from half an inch to an inch and a half between its extreme limits. The columns of the rectum form from four to ten, or more, strongly marked ridges, and a corresponding number of grooves, placed longitudinally along its internal surface, becoming narrower as they descend, and terminating abruptly at its lowest part.

The walls of this funnel are received into another shorter space, of a shape somewhat similar, formed by the divarication of the fibres of the external sphincter; which,—being much more considerable above, and gradually diminishing below, until, at the outlet, it nearly disappears,—creates another muscular funnel, covering the first at its neck and for some distance above, but extending downward about half an inch lower, to the point of greatest contraction of the external sphincter. The tegumentary membranes are continued from the orifice of the inner, to that of the outer funnel; and between these points, they are allowed some room for the slight enlargement before mentioned, which may be regarded as the middle region of the anal canal. These are minute details, but their importance will be more fully developed hereafter.

It is now necessary to speak of the terminal arrangement of the longitudinal muscular fibres of the rectum, and of their action on the anus; and here we are happy to bear testimony to the importance of the additions made to our knowledge of this subject by the present Professor of Anatomy in the University of Pennsylvania, whose kindness in demonstrating his series of preparations of the rectum enables us to present a more full statement of this arrangement than has yet been given to the public.

The *longitudinal fibres of the rectum* have been heretofore described as partly terminating in the superior margin and the outer face of the internal sphincter (*fig.* 1. i.), and partly continued over that face to be lost in the external, where it overlaps the internal sphincter (*fig.* 1. k.). Some of these fibres do indeed terminate as described, particularly at the latter spot, but Dr. Horner has succeeded in tracing others of these fibres much farther. Very many of them begin to lose a portion of their muscular appearance as they approach the lower edge of the internal sphincter, assuming somewhat the aspect of tendons; they are here gathered into numerous small fasciculi, the fibres of each fasciculus seeming to adhere to each other, until they double beneath the edge of the internal sphincter, which they appear to employ as a trochlea to revert the direction of their motion (*fig.* 1. l.), and are reflected upward on the mucous membrane. At this point (i. e. where they are reflected upward) they are collected into groups, one corresponding with the base of each column of the rectum; to which it adheres pretty closely in its passage. Each group then pursues its course upward in the duplicature of the column; but it speedily resumes its muscular aspect, the fibres being rapidly displayed as they advance, until they are finally inserted into the mucous membrane, sometimes as high as an inch and a half or two inches above the inferior edge of the sphincter internus (*fig.* 1. m.). It is obvious that this arrangement gives these fibres the power to draw down or even to revert the base of the columns, and a portion of the mucous coat of the rectum, thus explaining more fully the real nature of prolapsus ani; especially that species of it which occurs most frequently in childhood. A similar structure is obvious in the horse and other animals.

Fig. 1.

A vertical section of the Parietes of the Anus, passing through the middle line of one of the columns of the Rectum, and the neighbouring parts.

C. The Internal Sphincter, with its arched fibres transversely divided.

D, D. The plane of arched fibres of the muscular coat, similarly divided.

E. The point of greatest contraction of the internal sphincter.

F. The External Sphincter.

G. The point of greatest contraction, of the same muscle.

H. The plane of longitudinal fibres of the muscular coat, longitudinally divided. i. Some of these fibres terminating in the internal sphincter. k. Others, terminating in the external sphincter. l. The remaining longitudinal fibres, collected into a semi-tendinous fasciculus, passing over the lower margin of the internal sphincter, to be reverted upward within the duplicature of the column. m. These reverted fibres again becoming muscular, and terminating in the mucous coat.

L. The mucous coat.

n. A bristle in one of the sacs.

The *Levatores Ani* are two muscles originating from the internal surface of the pelvis, and inserted into each other, or into other soft parts along the median line of the body, in such a manner as to support and press upon the contents of that cavity and the abdomen from beneath, as the diaphragm does from above. These associated muscles close the pelvis below, forming a kind of basin of fibres with the concavity directed upward. The fibres originate from the bones of the pelvis, either directly, or through the intervention of the perineal fasciæ. They are directed, from the circumference of the pelvis, downwards and inwards, until they reach the median line, or the outlets of the organs which are situated there. The anterior fibres are attached around the membranous portion of the urethra, and the prostate gland; the lateral fibres are commingled with those of the outer margin of the external sphincter, and the posterior ones decussate their fellows of the opposite side, between the anus and the os coccygis. For a more detailed account of the origin of these muscles, see *Perineum*. Our present business is only connected with their action on the anus.

The levatores ani are the proper antagonists of the external sphincter. Their lateral fibres act most rapidly and extensively by drawing apart the two columns of that muscle, thus converting the elliptical form of the anal orifice into a circle; but their action does not cease here, for their anterior fibres are inclined backwards, and their posterior ones, forward, so that when called strongly into play, they all contribute to the enlargement of the anal orifice.

When at rest, the anus hangs suspended on the levatores ani, and such is the obliquity of the fibres of these muscles, that even when they are in action, if the rectum and abdominal muscles remain passive, they merely raise the orifice a little, without producing any very material impression upon the external sphincter. It is only when the rectum and its contents are forced downward by the contraction of the colon, or the abdominal muscles, that their power expends itself in producing dilatation. The other perineal muscles are only indirectly interested in the movements of the anus.

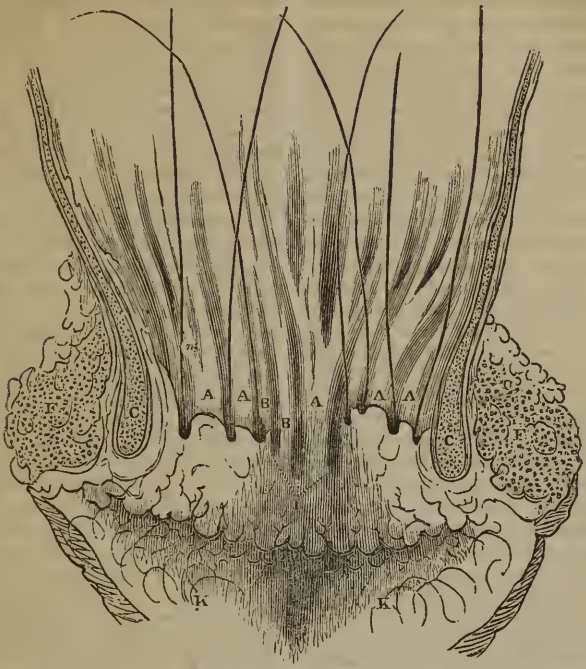
c. *Hemispherical Eminences of the Anus.* That part of the canal of the anus which we have styled the middle region, presents several slight, somewhat hemispherical or semi-ellipsoid swellings, corresponding, in number and position, with the bases of the columns of the rectum. They are probably produced by some peculiarity in the arrangement of the vessels of the part, and are not always very obvious after death. These appear to be the primary seats of those slight tumours which are so generally observed at the sides of the anus during the expulsive efforts of the rectum, returning within the canal upon the cessation of those efforts. When these tumours are enlarged by disease, their return may be prevented by the contraction of the external sphincter, and the lining membrane of the canal rests permanently everted to a greater or less extent. This is one of the most common forms of what are termed, not perhaps with rigorous propriety, *external hemorrhoids* (q. v.).

The swellings just mentioned are so closely approximated, when the parts are at rest, that they are in contact with each other about the middle of this part of the canal. The sulci formed by their gradual recession from each other above, correspond in number and position with those which separate the columns of the rectum, and they may be regarded as the final termination of those grooves. They are the seat of another peculiar and highly important arrangement, which we will now describe with some care, as we believe that no accurate description of it has ever been presented to the public through the medium of the press.

d. *Sacculi of the Anus.* The venerable Emeritus Professor of Anatomy in the University of Pennsylvania, had been in the habit of noticing in his former annual course of surgical lectures, a peculiar condition of the anus, in which there exist certain well-defined pouches or sacs within the canal, which, by occasionally arresting small portions of fæces, or minute foreign bodies, give rise to great inconvenience, and demand the performance of a peculiar operation for the relief of the patient. (See Art. III. § 12.) Dr. Horner, in prosecuting some examinations, post-mortem, with the view of elucidating this subject, was surprised to find a series of semilunar valvules, within the canal, such as have been hinted at, by certain anatomists, as an occasional occurrence, but the existence of which has been repeatedly denied by others. His attention being once fairly called to this structure, Dr. Horner discovered these valvules in every body which he examined for the purpose, and therefore draws the legitimate conclusion that they are normal and constant. The following descrip-

tion is drawn from the appearances presented by four different preparations, taken promiscuously from a considerable number which the Professor did us the favour to submit to examination, and the accompanying figure has been executed from one of them.

Fig. 2.



* A vertical section of the anterior parietes of the anus, with the whole canal displayed so as to show the relations of the sacculi of the middle region, and their relations to the surrounding parts, their orifices being marked by bristles.
A, A. Columns of the Rectum. B, B. Rudiments of Columns. C. Internal Sphincter. F. External Sphincter. I. Rudimentary or imperfect Sacculi. K, K. Radiated folds of the skin, terminating on the surface of the nates.
n. A bristle in one of the sacs.

Immediately below the margin of the internal sphincter we find a series of membranous pockets or sacculi, corresponding in number with the grooves between the columns of the rectum, one of which grooves is directed towards, and terminates in, each of the culs-de-sac. On the outer side, the sacculi are lined by the mucous membrane of the grooves, prolonged into the intervals of the hemispherical eminences already noticed, but which are not sufficiently distinct, after death, to be well represented in a drawing from nature. Internally, or on the side next the canal, the sacculi are completed by portions of loose membrane, which are processes from the reverted integuments lining the canal below. Each of these loose portions is attached at either end to the base of one of the columns of the rectum, and its free margin hangs in a curve between these points, thus forming a purse with the mouth presenting upwards, and resembling, in some degree, one of those formed between the valves of the aorta and the parietes of that vessel. Unlike the sacculi said to be sometimes formed by the intersection of the transverse and longitudinal folds of the rectum near the upper part of the anal canal, these pockets may be compressed, but cannot be obliterated by the distension of the anus. Their number, form, and position must necessarily vary, with those of the columns and swellings, which give them attachment; and, like the columns, some of them are frequently rudimentary. The upper margins of these pockets, taken collectively, appear to form the festoon mentioned by Cruveilhier as the termination of the cuticle.

The importance of the relations between these pockets and the phenomena of *fissure*, *stricture*, &c., are subjects for

future examination. As to their physiological uses, this is not the proper place to discuss all the ideas which they suggest; suffice it to say, that numerous mucous follicles appear to discharge themselves into their cavities, and that the passage of fæces must compress them and expel their contents, thus aiding in the lubrication of that part of the anal canal which is invested with cuticle, and therefore less capable of protecting itself, particularly at the moment when this lubrication is most necessary. The occasional existence of such sacs, or, as they have been termed, lacunæ, or valves in the anus, has been noticed by several writers: M. Ribes, one of the most laborious investigators of the pathology of the rectum, refers to Glisson, Ruysch, and Morgagni, as among the number. This gentleman, in an essay written some years ago, stated that he had been totally unable to detect them in the course of his dissections, though pursued for twenty-five years. He mentions, indeed, three or four depressions apparently lined with external integument, and perfectly smooth, placed in the anus, four or five lines above the margin, resembling the dilatations of the aorta and pulmonary arteries *after the removal of the sigmoid valves*, but he could not detect any opening or loose membrane about them. It seems probable, then, that he was deceived by the collapse or obliteration of the cavities, which prevented his observing the free margins of the valves, as they have been improperly called; this is the more probable, as his attention was particularly directed to the condition of the parts when in a diseased state, from the existence of fistula in ano. (*Recherches sur la situation de l'orifice interne de la fistule à l'anus. Rev. Médicale*, 1820.) In a more recent essay on the same subject, M. Ribes describes these pockets with considerable accuracy, stating that he has found in one subject, four, and in others, three depressions, protected by their loose, semilunar, valve-like covering, and that in the intervals between these, others less developed were noticed. (*Mémoires de la Société d'Emulation.* IX. 107.) Nowhere, however, are the precise position and connexions of these parts described with accuracy, though the author just quoted remarks that they are externally in contact with the hemorrhoidal plexus, and that the slightest wound or ulcer on their inner surface must endanger the occurrence of fistula.

Many authors have described the appearance of culs-de-sac somewhat similar to these pouches, formed by transverse duplicatures of the mucous tissue just above the anus or in the upper portion of its canal, passing from one column of the rectum to another. No doubt they may occasionally exist, but M. Ribes declares that he has never been able to detect them. The numerous partial partitions of the rectum, sometimes formed by the mucous membrane still higher up in the canal, are altogether beyond the range of the present article, and cannot be confounded with these more constant and regular valvules. (See *Rectum.*)

The third and least considerable portion of the anal canal is formed by the inversion of the external integuments. Its length is determined by the thickness of the skin and subcutaneous fatty cellular tissue, and in emaciated individuals it disappears almost entirely, or is converted into a simple areola. In health it forms a very wide and short inverted funnel, with the surface thrown into strong and numerous radiated ridges by the action of the sphincter externus. It is generally much more depressed in the male than in the female, and the sulcus or groove between the thighs, in which the outlet is placed, is also much deeper in the former than in the latter. In the female, indeed, it is placed almost on a level with the tuberosities of the ischia. The upper part, or neck, of this funnel, is elliptical, and is surrounded by those fibres of the external sphincter which are placed below its point of greatest contraction.

e. *Vessels of the Anus.* The *arteries of the anus* are small, but in operations upon this part they sometimes require the ligature. They are principally the branches of the external pudic, styled the inferior hemorrhoidal arteries, and a few ramifications of the ischiatic artery.

The *veins of the anus* are much more important. They are derived from the inferior mesenteric, pudic, ischiatic, and middle hemorrhoidal veins. The first mentioned vessel, being a part of the portal division of the circulation, is deprived of valves; and the same character is given to the hemorrhoidal plexus, formed by the various branches just enumerated. This plexus constitutes a free connexion between the portal, and the general venous system, and is therefore highly important in a medical, as well as surgical point of view. It surrounds the mucous coat of the rectum above the verge of the sphincter internus. When they are rendered varicose, or much distended, the branches of this plexus form projections in the canal, which

are of a blueish tint, and might be mistaken for the veins themselves, so thin and transparent is the mucous coat which covers them. They are embraced externally by the sphincter internus; but M. RIBES remarks that "tolerably large branches of the plexus are detached, pass through the muscle to its back, and immediately descend on its external face to its lowest edge, where they communicate anew, as it were, with the lower border of the hemorrhoidal plexus." (*Loc. Cit.*) This arrangement, he observes, when persons have been subject to violent attacks of piles, occasions the sphincter to resemble a portion of erectile tissue, in consequence of the number of large vessels which penetrate and embrace it. (Vide *Hemorrhoids.*)

The *lymphatics* of the lower and perhaps most of those of the middle portions of the anal canal, traverse the glands of the groin, which are not unfrequently swelled in certain cases of irritation about those parts. The *lymphatics* of the upper or mucous portion of the canal, traverse the glands of the pelvis.

f. *Of the Nerves of the Anus.* The sources and distribution of the nerves of the anus, have not yet received that rigorous examination which the importance of the functions over which they preside would warrant and render desirable. They are principally derived from the hypogastric plexus, and the last sacral pair of cerebro-spinal nerves. They therefore communicate partly voluntary motion and feeling, and partly involuntary motion and internal sensation; but the precise degree in which each portion of the canal enjoys these several powers, has not yet been satisfactorily demonstrated by dissection or experiment.

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ART. II. PHYSIOLOGY OF THE ANUS. There are but few remarks to be made under this head, except those which relate to the motions of the part; for in other respects, the subject falls naturally under the heads of the several tissues interested in the formation of the canal.

It has been too generally customary for

writers on the anatomy and physiology of the anus to confuse the two sphincters together in their descriptions. Now these muscles are not only distinct in their position, but in their physiological relations also, the one properly belonging to the splanchnic or involuntary muscular system, the other to that of voluntary motion, though possibly they may both be somewhat mixed in character. We shall speak first of their situation when in repose, and then of their several actions and their effects.

In the healthy state, the tonic contraction of these muscles is not sufficient to close the anal canal with any great force. The internal is much more contracted than the external, but does not produce very firm pressure upon the hemorrhoidal plexus, or the mucous membrane; nor is it in turn pressed upon strongly by those fibres of the external sphincter which surround its neck. A cautious examination, by the eye or finger, made without touching the verge of the anus, shows us that the two columns of the external sphincter are pretty widely separated from each other; but nervous sensibility and irritability are concentrated around this, as around the other great outlets of the body; and the effort to introduce the finger within the canal, sometimes produces a powerful contraction, which is almost, if not entirely, involuntary. This occasionally gives rise to a difficulty in introducing the injection pipe, but it is remarkable that the effort generally subsides when the passage has been effected, like the spasmodic contractions of the rima glottidis when a catheter has fairly entered the trachea. The internal sphincter opposes a constant resistance to the discharge of the fæces as they accumulate in the great pouch of the rectum. It seems to contract more and more strongly, while this accumulation is going on, until the pouch itself, aided by the voluntary efforts of the individual, is about to determine an evacuation; when it becomes relaxed in the same manner, or is distended by the same forces, as the circular sphincters of other hollow viscera. It does not appear that the external sphincter contributes in any considerable degree to this power of steady retention. The former muscle being funnel-shaped, its upper portion assists in retaining solid fæces only, and it also moulds or compresses them when in the act of passing; so as to prevent the too great distension of the middle region of the anal canal. Upon semifluid matter it can exercise but little influence, and when a considerable quantity of liquid collects in

the rectum, even the lower margin proves an insufficient guard, and powerful and exhausting voluntary efforts of the external sphincter are demanded to give a temporary and imperfect security against its passage.

When the rectum is nearly empty, the internal sphincter is scarcely antagonized by the longitudinal fibres; but when that intestine is distended, the form of its pouch, enlarging rapidly in every direction from the anus, enables them to act at a considerable mechanical advantage, on the orifice of the funnel; particularly when its upper part is much dilated.

The external sphincter is intended chiefly to resist an impending discharge when its colleague is in danger of being overpowered, and is antagonized by the levator ani.

The action of the levatores ani muscles does not appear to be very powerful. They act rather by supporting the sphincter externus at its proper level, than by actually dragging its columns asunder. When the latter is completely relaxed and thrust open by the descent of the anus under abdominal pressure, it is evident that the oblique fibres of the levators, if they did not contract, would permit the sphincter externus to descend also; and anatomists generally appear to have taken it for granted that such is the fact. Notwithstanding the resistance of the levatores, says Bérard (*Dict. de Méd.* Edit. 2d.), at each contraction of the diaphragm and abdominal muscles, the anus descends; after which it is again drawn up by the levators. We have endeavoured, by repeated inspections, conducted with care, to ascertain the true character of these motions, and have come to the conclusion that the external sphincter does not participate in the descent of the anus, unless when there occurs a severe straining. Upon the first effort at expulsion, the columns of the sphincter are thrown widely asunder without changing their level, or sometimes they even seem a little raised by the fibres of the levators, and their outlet assumes a circular form. Through the space thus allowed, the superior portion of the anus descends until the internal sphincter reaches, or even slightly passes the lower margin of the external, and these two muscles then act in concert to resist the farther dilatation of the orifice. This opening of the external sphincter also affords firmer support to the pouch of the rectum, without embarrassing the necessary motions of the anus. Now it is evident, that if this muscle does not descend when dilated, the fibres of the levators are shorter, or more contracted, in that condition of the parts, than when the sphincter is in action. When the efforts at expulsion cease, it is therefore obvious that the anus ascends, not by the contraction of the levatores ani, but by the natural elasticity of the parts, and by the tonic contraction of the external sphincter, then no longer counteracted by that of the levatores. The shape of the double funnel formed by the two sphincters, as described in the last article, explains the mechanism of this operation in a most satisfactory manner.

The nerves which supply the muscular coat of the rectum are known to be derived from the ganglionic apparatus; those of the *sphincters are said to spring from the spinal marrow;* but the character of the sphincter internus, its connexion with the common intestinal plane of arched fibres, its analogy to the pylorus and the cervical fibres of the bladder and uterus, may reasonably lead us to doubt whether it can act as a voluntary muscle in all persons, and under ordinary circumstances. The close association existing between the several great divisions of the nervous system, renders all its parts mutually dependent. There is probably no muscle in the body absolutely and at all times independent of the will, nor is there any that may not be called upon to aid in certain involuntary actions necessary to the maintenance of life. In the act of respiration, for instance, when regularly performed, the muscles attached to the clavicle and scapula remain passive; but in certain cases of thoracic effusion, and of cerebral injury, there is hardly a muscle of the trunk, or neck, that does not display the power of regular involuntary action, in aid of the process. No doubt the two sphincters both enjoy certain similar powers, and it may be that each receives a supply of nervous filaments from the cerebro-spinal, and also from the ganglionic apparatus; but both analogy and attentive observation lead us to consider the internal muscle as more immediately under the control of the splanchnic; and the external, under that of the cerebro-spinal centres. M. Bérard entertains some peculiar views on this subject, which we will give in his own words.

"In our opinion, the muscular apparatus which surrounds the inferior extremity of the rectum, may be presented in three different conditions, each demanding the intervention of the nervous system: 1. a state of contraction regulated by the will, to prevent an evacuation when imminently

threatened; 2. a state of permanent contraction or constriction, which retains the fæcal matters in the intestine; a contraction with which the will has no connexion, *and which is nevertheless immediately dependent on the cerebro-spinal nervous system*; 3. a state of relaxation *dependent on the will*, and therefore equally influenced by the nervous centres." (*Op. Cit.* p. 277.)

With regard to the first of these states, I have endeavoured in vain to detect any thing like voluntary contraction in the internal sphincter, and cannot regard it as immediately under the control of the will, except perhaps in cases which form exceptions to the general rule. It appears to be the external sphincter alone, that resists an impending evacuation in the manner described. With regard to the second state described, it is difficult to draw any distinction between this state of constriction, and the tonic power of contraction enjoyed alike by all the muscular fibres of the body; a power evidently more or less influenced by the will, in the voluntary, but nearly or totally independent of it, in the visceral muscles. This tone is diminished by any causes which produce enervation of the part, or which tend to concentrate nervous energy in other places. Among these causes we may enumerate, that which produces the alternate action and relaxation of the arched intestinal fibres so essential to their peristaltic movement, and which may be perhaps continued to the internal sphincter; and also that mental determination by which a voluntary muscle is relaxed, when its antagonist is called into action, as is the external sphincter, when the levatores ani produce a dilatation of its outlet. According to our view of these actions, therefore, *there is no peculiar nervous influence exerted upon the sphinctores ani*, but they are simply governed by the same laws which regulate the other muscles of the corresponding classes. The necessity of a special nervous influence to regulate the relaxations of the anus, has been urged, indeed, by several physiologists; and the learned Piedmontese Professor, M. Bellingeri, has endeavoured to establish the position by experiment, in the course of his researches upon the spinal marrow, nervous antagonism, &c. He asserts that the contractions of the sphincter ani are regulated by nervous fibres from the posterior columns of the spinal marrow, while its relaxations are under the command of others derived from the anterior columns. The confusion already complained of, resulting from the want of due attention to the distinct powers of the two sphincters, is obvious throughout these remarks of M. Bellingeri, and many important objections against the result of the experiments might be founded upon the reports of clinical practice, but the argument would lead us into a field of discussion too wide for the present article. Suffice it to say that the results, as stated by the author, are by no means conclusive, upon the point in question; and the subject will be hereafter considered more at length in some of those articles which require an examination of the rival discoveries of Bellingeri, Magendie, Charles Bell, &c. (See *Nerves*, *Innervation*, &c.)

Those longitudinal fibres of the rectum which adhere to the bases of the columns of that viscus, and are then reverted, to be inserted into the mucous membrane, appear to contract with some force during the effort to expel the fæces. They evidently tend to draw the membrane downward, so as to form a fold at the extreme edge of the internal sphincter, which may frequently pave the way for a prolapsus of the kind so often observed in children. They also tighten the corners of the semilunar flaps of integument which form the little sacs of the middle division of the anal canal, and assist in compressing and expelling the contents of these sacs, at the moment when the fæces are passing, and in preventing them from arresting portions of foreign matter, to the injury of surrounding parts.

Having thus described the actions of the various muscular parts immediately connected with the anus, it only remains to notice the changes effected in this canal by the more remote influence of the diaphragm and abdominal muscles.

At the commencement of the efforts at expulsion, the contents of the colon, and the intestines themselves are pressed downwards toward the pelvis. Yielding before this pressure, the pouch of the rectum is distended, and the upper portion of the canal of the anus begins to descend. The external sphincter is relaxed, and the fibres of the levatores ani contract, so as to dilate the middle region of the canal. The pouch of the rectum also endeavours to descend, but is effectually checked, except in cases of extreme effort, by the external sphincter, supported by the levators.

By the descent of the internal sphincter, the relation of the several parts is materially changed. The integuments of the lower portion of the canal are evolved on to the surrounding surface, and those of

the second portion take their place. The lower edge of the internal sphincter is brought into correspondence with the line of greatest constriction of the external, and the two muscles then act in concert. The longitudinal fibres of the rectum evert the edge of the mucous membrane in a fold that hangs over and protects, in a measure, the mouths of the sacculi of the anus. If the straining be severe, the edge of the internal sphincter and the mucous membrane may descend still lower, and then a considerable part of the integuments of the middle portion of the canal may be evolved onto the surface; the swellings situated at the base of the columns of the rectum, peculiar to this region, then appear externally, around the margin of the anus; and owing to the pressure of the sphincters on the lower part of the hemorrhoidal veins, these veins become enlarged, and give the swellings a resemblance to piles. Under these circumstances, the sacculi, or even the mucous fold overhanging them, may come into view.

The anus having reached its limit of depression, and the internal sphincter being still strongly contracted, the continued pressure of the abdominal parietes is expended in producing distension of the pouch of the rectum. Now the fibres of all hollow muscles, when distended to a certain degree, take on an involuntary action and endeavour to expel their contents, and it does not appear that the mode of expulsion in the case of the rectum differs materially from that observed in parturition or urination. The fibres of the internal sphincter contract at the same time with those of the pouch, but, aided by the abdominal pressure, the latter gradually overcome the former. The upper portion of the canal is evolved, and at length the anus is converted nearly into what its name implies—a ring. As the fæces distend the orifice of the internal sphincter, they enlarge the middle portion of the anal canal, and thus stretch and compress the sacculi. The mucous contents of these cavities, thus poured out at the moment of greatest need, must contribute very much to the security of the integuments below the margin of the mucous membrane; and the absence of this discharge, when the fæces are fluid, and come away without much distension, may perhaps account for the irritations around the anus, often following such stools.

The sensibility of the two lower portions of the anal canal is extremely great, but that of the superior is much less considerable. It is probable that the acute sensibility ceases contemporaneously with the disappearance of the cuticle, but this point has not been determined with sufficient accuracy. It is one of great importance in a practical point of view, for many of the surgical operations on the anus, performed by ligature, are exquisitely painful, and the use of the knife is sometimes dangerous. In the choice between the two modes, therefore, it becomes highly necessary to judge correctly of the degree of sensibility, as well as of the vascularity of the parts interested, in each individual case.

If any accuse us of too much detail in this and the preceding article, we must plead the importance of the subject, and the neglect with which it has been treated by most writers. We have introduced nothing which did not appear necessary to display the existing state of our knowledge of these parts, and nothing that will not tend to elucidate the pathological remarks contained in the next article. For other details with regard to the discharge of fæces, see Art. *Rectum*.

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ART. III. PATHOLOGY OF THE ANUS. In treating this subject, we shall avoid the consideration of those morbid affections which may be more conveniently referred to the articles on the pathology of the rectum and the perineum; and shall confine our observations to such diseased appearances as take their name from this region, in which they are wholly or partly seated. The therapeutical and surgical treatment will be given in connexion with the history of each disease, in the several sections on 1, Neuralgia; 2, Spasm; 3, Atony; 4, Injuries; 5. Prolapsus; 6, Inflammation; 7, Blenorrhagia; 8, Organic Stricture; 9, Tumours; 10, Ulcers; 11, Fissure; 12, Preternatural Pouches; 13, Abscess; and 14, Fistula. The subject of artificial anus being intimately connected with hernia and obstructions of the intestines, will be referred to the appropriate articles; and much of the matter relating to preternatural and imperforate anus, will be most naturally considered under the head of vices of conformation. We have

nevertheless devoted a short section of the present article to the last named error of structure. Hemorrhoids demand a separate article, as they involve parts and actions so far removed from the anal region, that their pathology could not be properly included.

§ 1. *Neuralgia of the Anus.* M. Campaignac (*Journ. Hebd.* 1st series, II. 396.) has described, under this name, a disease which in some of its forms is sufficiently familiar to the profession in America. M. Velpeau also quotes Ullman (*Encycl. Worterbuch der Med. Wissenschaft.* I. 634.), for a description of the same disease. Although we have strong doubts whether the primary seat of this affection is in reality the anus, and though further researches may possibly prove that it is not essentially a neuralgic affection, our avowed design of giving a view of the existing state of medical knowledge and opinion, obliges us to notice it here; referring to the article *Bladder*, for a more complete account of the whole progress of the disease.

The causes, says Velpeau (*Dict. de Méd.* ed. 2d. III. 282.), are unknown. Neither redness, swelling, nor the slightest alteration, are perceptible in the part. The fundament becomes the seat of lancinating pains which appear to be very superficial, and cause the patient to dread the least pressure on the part. These pains are frequently paroxysmal in their attack, sometimes coming on suddenly, sometimes more slowly, leaving the patient entirely free during the intervals. In other cases, the pains are constant, with occasional exacerbations. In some persons, the anus appears to undergo momentary and forcible contractions, followed by speedy relaxations; in others, on the contrary, it is seen to expand to such an extent that involuntary discharges take place. The neck of the bladder soon becomes affected, and all the rational signs of urinary calculus are shortly superadded. The symptoms are rendered more severe by exercise, particularly if the patient becomes heated.

M. Velpeau goes on to describe the train of symptoms as observed in the urinary apparatus. (See *Bladder.*) According to the authorities quoted, no course of practice has been found generally applicable in this disease. Baths, opiates, antispasmodics, the pills of Méglin, &c., have been tried, in every form, without effect. When the bladder becomes affected, the introduction of the catheter is attended with great pain and a remarkable burning sensation. According to Velpeau, this pain sometimes ceases instantaneously when the instrument has fairly entered the bladder; but Campaignac (*Op. Cit.*) remarks that when the mucous membrane of the bladder becomes irritated in the progress of the disease, all attempts at exploration are productive of acute suffering. He mentions, however, a case treated by M. Cheneau, in which the paroxysms were very violent, but were immediately calmed by the catheter; which case was finally cured by its repeated employment. Velpeau states that those patients who have been operated upon, under the impression that there were calculi in the bladder, have generally recovered both from the operation and the disease. One case only, terminated fatally, and the subsequent examination discovered no morbid appearances either in the bladder or the anus. A patient who complained only when sitting, and who was able to pursue his usual avocations, was relieved by the application of pledgets imbued with an unguent containing the extracts of belladonna and opium; another, similarly affected, received no benefit from this treatment. In the case of one strong, robust patient, baths, general and local bleedings, the pills of Méglin, and the topical use of belladonna and opium, were employed, but no benefit was obtained until after the cessation of all remedial measures; in another, the use of the carrot tisane, soda-water, lime-water and milk, the pills of Méglin in large doses, and the pills of cynoglosum, finally effected a cure. Clysters and gentle purgatives he recommends in order to prevent the exacerbation likely to attend on the discharge of hardened fæces in costiveness; but he confesses that the therapeutical management of this disease is as little understood as its nature; and he states that it wears off with time.

It appears to us more than probable that several different affections have been classed together, by the authorities just noticed. Those of the cases mentioned by M. Campaignac, in which the symptoms simulate those of calculus, and which, in their advanced stage, produce extensive discharges of mucus from the urinary organs, seem to resemble a disease not unknown in our hospitals, the proper or primary seat of which is the bladder: it will be described at length under the appropriate head, where the question of the propriety of arranging it with neuralgic affections will be considered. Other cases on record were very probably the result of

those changes in the structure of the anus, noticed by Dr. Physick, which produce false pouches in the middle and lower region of the anal canal; changes which we believe had escaped detection, until the attention of the profession in this country was called to them by that eminent surgeon in his lectures. (See § 12.) Still there can be no reason to doubt the occasional occurrence of genuine neuralgia, primarily seated in the nerves of the anus and its neighbourhood, similar in character to that which occurs in other parts; but we are convinced of its extreme rarity, and feel assured that increased attention to the condition of the canal and the organs that surround it, will lead surgeons to be much more cautious in referring cases to this head. (See the sections on *Spasm*, *Fissure*, *Stricture*, and *Preternatural Pouches.*)

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Campaignac. *Journal Hebdomadaire.* 1st series. I. 634. Paris, 1828.

§ 2. *Spasms of the Anus.* Besides the various irritations located primarily in or about the canal of the anus, there are many other causes capable of producing pain and spasm in that part. The associations of the anus with the neck of the bladder and the urethra in the male, and with the vagina in the female, are so close, both in consequence of their proximity, and their combined action in the performance of certain functions, that any unusual excitement of the latter organs is exceedingly apt to extend itself to the former. Spasmodic stricture of the urethra, or other irritations at the usual seat of that affection, such as are very frequently produced by excessive indulgence in venery or in certain unnatural crimes of like character, often occasion spasmodic contractions of the external sphincter ani muscle, and consequent irritation of the lower portions of the canal. After each unusual indulgence, severe burning and sometimes lancinating pain is felt in the neighbourhood of the bulb of the urethra; the patient is tormented by a constant desire to urinate, and if the absence of stricture enables him to evacuate the bladder completely, he continues discharging the urine guttatim almost as fast as it accumulates. After each discharge, a spasmodic contraction of the accelerator urinæ occasions an intolerable ardor. The sphincter ani participates in the spasm, and the same kind of pain is experienced in the anus. The rectum is also provoked to expel its contents, but it sometimes succeeds with difficulty, in consequence of the constriction. During the flow of urine and the passage of fæces, the symptoms are in a great degree relieved, and they are considerably mitigated by the descent of the upper portion of the anus under abdominal pressure, so that the patient is induced to make frequent ineffectual efforts to go to stool; but the pain returns in full force, upon the cessation of the efforts. The duration of the symptoms is very various; sometimes they pass off in half an hour, and at others they endure for twenty-four hours or longer; while they continue, they are often very severe. When they have become habitual, they do not disappear with the removal of the usual exciting cause, but are reproduced by the slightest accident, such as may occur in riding on horseback, over-exertions, &c.; and sometimes an attack is determined simply by costiveness. Paroxysms that occur in the night are generally the most painful. Cases of this character have been occasionally mistaken for neuralgia of the anus, the symptoms being very analogous. This error is more likely to occur because of the extreme aversion generally displayed by the patient to acknowledge the true cause of the complaint; for although it is undoubtedly produced in some instances by unavoidable accidents, it is much more generally the result of improper indulgence.

When the same species of irritation is extended to the neck of the bladder, the prostate gland, or the vesiculæ seminales, whether it be caused by similar habits or by calculus, enlarged prostate, &c., the train of anal symptoms is somewhat varied. There is less burning pain in the intervals of the efforts at stool, but there is more soreness from severe involuntary tenesmus; the external sphincter is still spasmodically affected, but the levatores ani partake of the spasm, and frequently overcome the resistance of the sphincter; even the muscular fibres of the rectum, and the internal sphincter, may experience the same kind of irritation. Hence result the alternate contraction and dilatation of the anus and the involuntary discharges, noticed in the preceding section, as also, the severe tenesmus, and the prolapsus of the mucous membrane, so frequently observed in the paroxysms of stone and other diseases in or about the bladder.

We believe that in the great majority of cases, the train of symptoms just described originates in the urinary apparatus,

and that the anal affection is consecutive. This complaint, though sufficiently common, does not appear to have attracted the attention it deserves, for its effects are not unfrequently enumerated among the characteristic symptoms of diseases, of which, perhaps, they are as frequently a cause as a consequence.

The treatment of the first form of this affection consists in the removal of the exciting cause, and the employment of measures calculated to combat spasm in general. Mild cases seldom come under the notice of the surgeon; but in those which have become habitual, we have succeeded best by the long-continued application of considerable heat by means of bottles of hot water, and by injections of mucilage of the pith of sassafras into the urethra, and, in very severe paroxysms, opiate enemata. To prevent the recurrence of paroxysms, all that is required is the avoidance of every cause of mechanical irritation, violent exercise, and such errors of diet as are calculated to render the excretions unusually stimulating. In some cases, the application of local heat increases the violence of the symptoms, and relief is obtained from the very opposite course. When inflammation supervenes upon the spasm, leeches and cold to the neighbouring parts are strongly indicated. They should be addressed as nearly as possible to the original seat of irritation, when it can be ascertained. If, as sometimes happens, fever should be induced, it is to be treated on general principles.

The treatment of the second form of this disease does not differ essentially from that of the first, so long as it remains simple in character; but as the parts interested are more numerous, involved to a greater degree, and deeper seated, constitutional symptoms and secondary complications are much more likely to occur. Its causes are often incapable of immediate cure; the treatment is therefore merely palliative, and will be noticed under the heads of the several diseases that produce it. (See *Prostate Gland*, *Bladder*, &c.)

But spasms of the anus do not always depend upon irritation of the urinary organs. Cases of far greater violence and danger, though fortunately less frequently met with, originate from irritations of various kinds seated in the anus itself, or in the rectum. Mr. Calvert, who has given a very accurate account of this disease, describes it as appearing at first with some degree of smarting pain, and a feeling of resistance at the orifice of the gut during an evacuation. After some time the difficulty of voiding fæces becomes much greater, the stools being rendered small, flat, and twisted spirally as in cases of stricture of the anus or rectum, and the discharge intensely painful. The dimensions of the masses of fæces are not uniform, being sometimes large and evacuated with force and rapidity; at others, as small as a piece of fine tape, and passed slowly, with great exertion. This variation shows that the spasm extends to all the muscles of the anus, and even to those of the rectum, affecting sometimes one part, and sometimes another, and furnishing the means of distinguishing the complaint from organic stricture. According to Mr. Calvert, the pain comes on soon after the patient has had a motion, continues for a short time, and does not return until the following day, or still later if the bowels are not moved in the interval; but in persons of very irritable habits, it may be produced by the slightest causes, such as the escape of wind, unusual exertion, passions, or any other cause of general or local excitement. The pain is sometimes intolerable, and gives rise to cries of agony. Occasionally, it assumes a periodical character, coming on in some patients regularly, and generally in the evening of each day, with a total calm in the intervals; and in others, making its attack at irregular periods, leaving behind it a constant uneasiness, numbness, or aching pain. (*Pract. Treat. on Diseases of Rectum*, &c. p. 211.). According to Mayo, the attack generally comes on during the night, waking the patient with excruciating pain. In some cases, its approach is gradual for several days, and then it as slowly declines; while in others, it seizes the patient suddenly, and after lasting a certain time, as suddenly disappears. (*Obs. on Diseases of the Rectum.* p. 185.) Copeland, who met with many cases of constipation and other more painful and serious consequences from contraction of the anus, where no stricture or other morbid change of structure could be discovered, attributed the symptoms to an undue development of the sphincters, for he always found both these muscles very much enlarged and unusually strong in such cases. Boyer, who considered spasm of the anus chiefly as connected with fissure (q. v.), met with cases of difficulty so early in life that he considered the disease as congenital. Calvert thinks it more reasonable to suppose that the increased strength of the sphincters is owing to a hypertrophy induced by frequent irritation

and the constant recurrence of the spasm. The latter author remarks that the degree of contraction is not always in proportion to the sufferings of the patient; but when in this complaint the sphincters are rigidly contracted, intense pain is a necessary consequence of anything that irritates the anus, or produces dilatation suddenly. If, in this state of things, the finger be passed within the anus, the external sphincter muscle is found to encircle the orifice like a thick, unyielding ring; and, higher up, the parietes of the gut feel unusually firm and solid, when pressed against by the point of the finger, from a similar development and contraction of the muscular fibres of the internal sphincter; while, in some cases, where there is much vascular excitement, the contraction has been found to extend along the whole of the rectum. (*Op. cit.* p. 213.) MAYO also objects to the use of opiate suppositories in these cases, because any attempt to introduce them occasions increased contraction of the irritated sphincters. (*Loc. cit.*) It is remarked by nearly all the writers, that the persons most subject to this complaint are females, and individuals of a nervous temperament.

It is much to be regretted that so few surgeons have studied the diseases of the rectum and anus with the exercise of that care and discrimination which their importance demands. We think it will be evident to all who read the hasty outline of the opinions of different authors just given, that spasm of the anus is more frequently a symptom than a distinct affection, and that writers have erred in enumerating under this head the features of various complaints, not less different in their appropriate treatment than in their causes and nature. Nevertheless, we feel considerable diffidence in attempting to clear the diagnosis of these affections, for, although some of them are met with not unfrequently, and are, therefore, sufficiently familiar, there are others of rare occurrence everywhere, and almost unknown on this side of the Atlantic,—nor are the recorded cases and examinations presented to us with all that detail and precision of language which are required to render documentary evidence in surgery a substitute for personal experience. The following remarks, however, will perhaps prove valuable, by calling the attention of the profession more particularly to the subject hereafter, and by explaining the confusion and conflict of principles, so obvious in the practical directions of authors.

The cases properly ranged under the head of neuralgia of the anus and bladder, so styled by M. CAMPAIGNAC, as noticed in the preceding section of this article, are not very strongly distinguished in their first rise, being liable to be mistaken for spasm from irritation of the urinary organs—the common and comparatively mild complaint, noticed at the commencement of the present section. They are recognized with great facility at a later period. The absence of all perceptible disease of the rectum itself, the great extent and gravity of the symptoms affecting the urinary apparatus while there exists no obvious cause for them; the extreme pain generally produced by introducing the catheter, and the frequent cessation of that pain when the instrument has fairly entered the bladder; and, more especially, the presence of the rational symptoms of calculus, give to this group a peculiar character, and the cases are more likely to be confused with those of diseased prostate gland, as described by HOME, than with spasm of the anus. (See *Bladder, Neuralgia of.*)

Another group of cases is characterized by the ardor urinæ, confined to the region of the accellerator urinæ muscle, the burning pain in the anus, and other symptoms, originally occasioned by vicious or imprudent indulgence, or by injuries to the penis from the saddle in riding, or from falls, the improper management of catheters, &c. Both the symptoms and treatment of this group have been considered in the commencement of this section. It is proper to mention, however, that these cases may no doubt produce consecutive changes in the anus, and thus bring on some of the other forms of spasm. In spasm of the anus from urinary irritations, the constriction of the external sphincter is generally the most severe, and even this is not commonly very hard; so that there is little difficulty experienced in introducing the finger. The strongest diagnostic mark which distinguishes spasm of this kind from that arising from disease originating in the anus, is this: in the latter case, the patient dreads the attempt at evacuation, because of the intense agony that it occasions, and the tenesmus is only indulged involuntarily; but, in the former disease, straining produces temporary relief, by distending the external sphincter, and the introduction of the finger, so far from increasing, actually diminishes the suffering.

The sphincter externus is subject to common cramp, and this may prove very troublesome. We have seen several cases, one of which occasioned great soreness

and considerable inflammation in the canal for several days after the attack. The cases mentioned by Mayo as coming on suddenly at night, were probably of this character, but when he draws the general conclusion, that "spasmodic contraction of the sphincter is a kind of cramp," he certainly speaks very incautiously. There can be little in common between cramp of the sphincter and the attacks coming on gradually and passing off in the same manner, nor is there any stronger connexion between the modus operandi of the two plans of proceeding which he recommends for the treatment of the complaint, to wit: a mould-candle introduced as a bougie, in some cases, and a brisk cathartic in others. Cramp of the external sphincter is a rare occurrence, and happens generally in persons very liable to a like affection of the other voluntary muscles. It is relieved by similar measures. The paroxysm, in the few cases we have seen, was relieved by the gradual introduction of the finger, so as to overcome the constriction, but, in two instances, it returned repeatedly. Both of these cases were greatly relieved by the steady application of heat to the part, but one of them did not finally recover until he had been for some time under treatment for irritation of the small intestines, upon which the cramp in this and other muscles appeared to depend. In all, the constriction was very hard, and the pain excessive.

Another form of the spasm of the anus is that which comes on without any obvious cause, either in the urinary apparatus or the anus, the integuments preserving their flexibility, and remaining unaltered, except that they are occasionally swelled a little by slight inflammation from the pressure of the stricture. Cases of this kind are those which are so often styled nervous. They occur chiefly in persons of delicate frame, sedentary habits, and nervous temperaments, and they appear to result from an unusual irritability of the anus, rendering it liable to spasm from slight causes. The attacks in this form are often intermittent, appearing at regular periods, and leaving the patient in a perfect calm during the intervals. This is the form which has been compared by Calvert to tic doloureux, and the causes of which appear sometimes to be congenital. (See Merat. *Dict. des Sciences Médicales.* XV. 547.) The undue development of the sphincters, noticed by Copeland, Boyer, and the author just mentioned, is noticed chiefly in cases of the group of which we are now speaking We are compelled to prefer the explanation of this development, given by the latter, to that of either of the former surgeons, as more consistent with the ordinary course of nature, and to regard this appearance as an actual hypertrophy of the sphincters from too frequent and too violent action. Like other similar nervous affections, this seems to be rendered more unmanageable by depression of spirits and strong emotions of mind. It is distinguished from the neuralgia, so called by M. Campaignac, by the excruciating pain in the anus, which is sometimes so severe as to occasion syncope, while there is little uneasiness in the urinary organs;—from spasm consequent upon irritation in the urinary organs, by the intolerable agony on going to stool, and on the introduction of the finger during a paroxysm, which sometimes produces a marked convulsion;—from cramp of the external sphincter, by the same signs;—and from most other cases of spasm, by the regularity of the attacks, or by the absence of all strongly marked inflammatory symptoms. The only form of the disease with which it is very likely to be confounded, is that produced by fissure of the anus; with which it appears to be frequently complicated, and from which it cannot be clearly distinguished by any rational sign. This difficulty is of little importance, for the surgeon can and should determine the presence or absence of fissure, in all cases of doubt, by a proper examination. (See § 11.)

In this group of cases, the various narcotic remedies employed in neuralgic diseases generally, are plainly indicated; but the degree of benefit likely to result from them, cannot be foreseen from any evidence now before us. It is probable that most of the cases in which their employment has proved successful, may have belonged to this group, and that many cases in which they are stated to have failed, may have been of a different character, so that the remedies were inapplicable to the circumstances—at all events, the details necessary to render the question a clear one have not been given, and it may be hoped that a better diagnosis will, at some future day, remove this disease from the list of opprobria. Mr. Calvert suggests the propriety of testing the powers of quinine and carbonate of iron, in the regularly intermittent cases.

The causes of muscular spasm, when it occurs as a symptom of inflammatory affections of the anus, are very various. The complaint may be induced by diarrhœa, strictures or ulcerations of the rec-

tum, fissure, rhagades, hemorrhoids, or other tumours, situated in or near the canal. This form of spasm is generally distinguished from all others by the constant presence of more or less pain or uneasiness in the anus, the disease being liable to remission, but very rarely to a distinct intermission. The treatment, of course, must be various as the causes. It consists simply in the relief or cure of the inflammatory affection, or the removal of the consequent excrescence which has induced the spasm. The measures adapted to each of the causes will be found in the appropriate section of this article.

Having thus attempted to classify the several groups of cases commonly arranged under the head of *spasm* of the anus, and, having offered a few remarks on the treatment of each group, it only remains to add one or two observations on the examination of patients, and the operations sometimes rendered necessary in most forms of this disease.

When called to a patient labouring under spasm of the anus, it is the imperative duty of the surgeon to satisfy himself, by careful examination, and, if necessary, by ocular inspection, as to the condition of the whole anal canal, and, as far as possible, of the neighbouring parts of the rectum. He should inquire and ascertain if there is any tendency to prolapsus during the efforts at stool. He should likewise investigate the condition of the urinary apparatus, and, when necessary, the moral habits of the patient, the condition of his bowels, and the nature of his customary diet. With these lights he will be able to determine the true seat and cause of the disease, and to regulate the course of practice accordingly; but we should be very cautious in pronouncing a case to be simply neuralgic, for, in a vast majority of instances, some concealed inflammation may be detected when we take sufficient pains to examine for it. As a general rule, in all forms of this complaint, the bowels should be kept open, by diet, if possible, and if not, by gentle laxatives or the mildest enemata. No purgative containing aloes is admissible. Perhaps the best laxative in cases of the habitual costiveness of sedentary patients, is uncombined calomel, given in the least dose that will produce one or at most two free discharges, and repeated every second or third day, for a week or more, renewing the treatment from time to time until the habit is conquered. From very extensive trials, we may mention that this dose varies from three to five grains; but generally the former quantity will be found ample, after it has been employed two or three times. All highly stimulating food and drinks should be totally interdicted.

As cases of spasm of the anus sometimes produce all the fatal consequences of strangulated hernia, tympanitis, or peritonitis (Richerand, *Nosogr. Chir.*), and, as many others prove at once intolerable, and incurable under medical treatment, it may become necessary to divide the sphincters, and to prevent their immediate reunion, in order to relieve the constriction and pain. All the writers agree in this recommendation; but Calvert very properly cautions us against a hasty and unnecessary resort to so severe an operation, as it is not altogether unattended with danger; and notwithstanding the powerful testimony of Boyer in its favour, it does not always effect a cure, for it has failed in the hands of several eminent surgeons. (See *Fissure.* § 11.)

Dilatation by bougies, so very useful in strictures of the rectum, have been opposed by many in those of the anus, because of the intense pain attendant upon their introduction. Boyer testifies that in every case in which he made the attempt to dilate by bougies, they proved either useless or injurious (*Mal. Chir.* tom. X.), producing, in some cases, a still more rigid contraction after every attempt, until the canal was nearly obliterated, so that even a clyster-pipe could not be passed. M. Delpech also substantiates this fact. (*Prècis Elémentaire des Mal. Chir.* tom. I.) Yet there is strong authority in favour of the occasional usefulness of dilatation by tents or bougies, even in cases complicated with fissure and other inflammatory affections of the canal. (See *Fissure.* § 11.) It is difficult at present to point out the particular cases to which the plan of dilatation is applicable; but it seems to be generally conceded that even where it proves useful, the introduction of the instrument produces a very great exacerbation of pain, which often continues for several hours, and then entirely subsides. When, therefore, the introduction of a tent or bougie is not followed by considerable relief after a reasonable time, the propriety of its repetition must be very questionable, for we should then dread a permanent increase of difficulty after each attempt, and the occurrence of those evils noticed by Boyer and Delpech.

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See also—the General Treatises of CALVERT, COPELAND, and MAYO, on Diseases of the Rectum, BOYER'S Maladies Chirurgicales, DELPECH'S Prècis Elémentaires de Malad. Chir., and Bibliography of *Fissure*.

§ 3. *Atony of the Anus.* In consequence of frequent and undue dilatation of the anus, the two sphincters sometimes cease to contract with sufficient force, and the canal becomes permanently enlarged. The same result also happens occasionally from paralysis consequent upon concussions of the spine, and the enlargement may then continue after the spine has recovered from the effects of the injury. Among the most fertile causes of the worst forms of this affection, may be ranked the indulgence in unnatural crimes, fortunately little known in this country, but which the crowded condition of those schools of vice, our public prisons and alms-houses, are rapidly introducing amongst us.

Slight shades of dilatation from atony of the sphincters are very common among men of sedentary habits, more particularly such as are esteemed good livers; though they are seldom made a ground of complaint, and have received much less attention than they deserve. The immediate consequences of this loss of tone are, a slight irritation of the teguments, and an increased secretion of the mucus of the canal, which sometimes produce serious inconvenience, although unattended by pain. As ulterior results, this morbid condition may determine the development of many of the more serious diseases of the part, under the action of agents which would prove harmless in a healthy condition of the anus; and these diseases may recur after a cure has been accomplished, if the atony be neglected. The complaint, in such cases, yields almost invariably to a regimen and treatment calculated to regulate the habitual action of the bowels, aided by that most powerful but much neglected remedy in irritations of this part, the local application of cold. The best mode of applying this remedy is to throw a continued stream of cold water upon the anus; and it is much to be regretted that the apparatus for what is termed the *douche ascendante* is so seldom employed in this country. Cold ablutions, however applied, are much less efficacious.

The worse forms of the complaint, originating from the causes already enumerated, or from tumours, or former operations on the part, are attended by permanent stretching of the teguments themselves, remaining after the sphincters have in great degree recovered their tone. Such cases yield only to the removal of the cause, to the use of astringents, or, in the most obstinate, to the excision of some of the redundant folds of the skin. (See *Prolapsus Ani.* § 5.)

If the affection is the result of vicious habits, says VELPEAU, the anus is strongly excavated, like a funnel; in other cases, it is salient, depressed, or irregular, but never infundibuliform. Involuntary stools and prolapsus ani are often occasioned by this kind of enlargement. When the causes which originally produced it are incurable, as in some cases of tumour and paralysis, the case is beyond the reach of art.

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§ 4. *Injuries of the Anus.* The anus is subject to wounds, contusions, and lacerations, like other parts of the body; but the history and treatment of such accidents require little distinct notice, being plainly inferred from the structure of the canal and from well-known general principles. Many of these injuries will be noticed under other heads, and we will merely remark in this place, that those lacerations or incisions which are situated immediately in front or in rear, heal with much greater difficulty than those which have a lateral direction, and are apt to leave crevices or linear ulcerations in the canal, that are very obstinate. Dr. PHYSICK objects to making incisions from the anus directly toward the centre of the perineum or toward the point of the os coccygis, on account of the difficulty just mentioned, which he attributes to the motion of the thighs upon each other preventing the continued adaptation of the surfaces of the wound during the cure. He informs us that he has not observed spasms of the sphincters, or those grave accidents characteristic of fissure of the anus, as a consequence of these crevices. Among the most frequent causes of injury to the anus, we may notice carelessness in the introduction of injecting-syringes. The general construction of these instruments is bad, for the point should be much larger, rounder and shorter, to secure the patient against accidents from careless operators. The greater prevalence of diseases of the anus and rectum on the continent of Europe is fairly attributed, by Mr. MAYO, to

the habit of constantly taking enemata, and for similar reasons they are less prevalent in this country than in England. The habit may be commendable, but the careless mode of administration sometimes produces serious evils to the anus, the prostate gland, or the rectum. (See *Rectum*, *Enemata.*)

The integuments of the middle and lower portion of the anal canal, are capable of enduring great distension when slowly acted on, but when suddenly enlarged they are sometimes torn; an accident that may occur from the expulsion of hardened fæces, or from the discharge or introduction of foreign bodies (Cruveilhier. *Dict. de Méd. et de Chirurg. Prat.* Art. *Anus*). A longitudinal or irregular crevice is produced, which may degenerate into fissure or some other form of ulceration. The superior portion of the canal is subject to another kind of laceration, involving the mucous membrane. It results from the discharge of large masses of hardened fæces, and is irregular, but generally transverse in its direction. It appears that this laceration is produced by the resistance to the progress of the fæces, by their excessive friction, or by their becoming engaged in some of the accidental circular wrinkles of the mucous membrane, often noticed in this situation. The part, once torn, speedily ulcerates. The edges become somewhat hardened, and the surface exquisitely sensible. The dread of pain induces the patient to avoid all attempts at going to stool as long as possible, and thus aggravates those very causes that originally produced the accident, and render it difficult of cure. M. Mayo, who gives us several very interesting cases of this affection, describes it under the title of *fissure*, but the term fissure (q. v.) is applied to a class of anal ulcerations differing materially, both in their seat and nature, from the injuries of which we are speaking. (*Obs. on Injuries and Diseases of the Rectum.*)

The symptoms and treatment of other ulcerations of the anus, will be considered when we come to treat of inflammation of the anus, and its consequences. Their presence is determined very easily, in most cases, by inspection or the touch.

A cause of injury to this part, which is by no means uncommon, is the introduction of foreign bodies from without, or their lodgment, after passing through the route of the intestines. Such causes frequently give rise to abscess or fistula. It is more than probable that the sacculi of the anus, when diseased, or changed in the shape, or limited in their motions by alterations in the surrounding parts, may contribute much to the frequency of the arrest of seeds, and other small solid bodies, in the anus. The records of surgery are rich in instances of this kind. These sacculi also furnish a secure lodgment to certain entozoary animals, particularly to numbers of the *Oxyurus vermicularis*, or ascarides, as they are incorrectly termed. The difficulty of dislodging these worms entirely is but too well known, and is well accounted for by the structure of the sacculi. We recollect to have heard Professor Gibson remark, some years since, that he had employed, with great success, a steel spoon like a common mustard-spoon, to scoop out animals of this kind. The manœuvre is worthy of record, as no instrument could be contrived better adapted to the purpose of evacuating the sacculi in the most complete manner, with little force or injury, not only when worms are present, but upon all analogous occasions. Pins, needles, fish-bones, and other sharp-pointed bodies arrested in the anus, sometimes give rise to great difficulty in the extraction. One case which we have encountered, suggested the use of an instrument on the principle of the œsophageal forceps of Dr. Bond of Philadelphia, for the removal of such bodies.

Bibliography.—Payne, (Rt.) *Case of a fork thrust up the anus, and extracted from the buttock.* Phil. Trans. abr. VII. 5. 1725.

Sherman, (Mr.) *Case of a fish-bone arrested in the anus, discharged by abscess, one year after being taken into the stomach.* Phil. Trans. Mihle's Abr. II. 367. 1723.

Harrison, (E.) *Case of an apple-core, forming a fistula in ano, eight months after being eaten.* Memoirs of the Medical Society of London. V. 154. 1796.

Blair, (Wm.) *Case of a piece of hard toast arrested in the anus, and extracted by forceps.* Medical Facts and Observations. VI.

§ 5. *Prolapsus Ani*—called also *Exanea* and *Archoptosis*. This term has been applied, by surgical writers, to several distinct accidents, and it is necessary, in order to avoid confusion, that we should confine its signification within narrower limits.

The different kinds of tumours formed by protrusions of one or more coats of intestine from the anus, may be arranged under four heads; first, invaginations of the colon, gradually elongated until an inverted portion of the gut appears externally; the intussusception sometimes taking place so high in the abdomen that the cœcum itself is presented (see *Intussusception*); secondly, invaginations at the promontory of the sacrum, the extremity of the sigmoid flexure of the colon being received into

the upper portion of the rectum, and finally reaching the anus (see *Colon*); thirdly, invaginations of the superior portion of the rectum itself into the inferior dilatation or pouch of that viscus (see *Rectum*); and lastly, eversion of the mucous coat of the superior portion of the anal canal, and the neighbouring portion of the rectum. Some surgeons would add a fifth class of cases; those in which all the coats of the rectum are inverted at the anus: but, although we do not feel warranted in denying the possibility of such cases, we cannot conceive how they can exist as a primary affection. The close attachment of the posterior surface of the rectal pouch to the parts about the os coccygis, and the still more intimate connexion between its anterior face and the prostate gland, and the base of the bladder, must necessarily prevent any inversion at this point from taking place, unless after long-continued dragging has elongated the dense cellular bands that oppose it; and such dragging is only likely to occur as a consequence of an old and neglected invagination of the third named class.

We shall consider the term *prolapsus ani*, in this article, as applicable to the fourth class of cases enumerated, referring the reader, for further information as to the other accidents, to the several heads above mentioned, thus escaping the confusion likely to result from treating in one article diseases or accidents varying so widely in their seat, consequences, and mechanical treatment.

In the two preceding articles we have spoken of the amplitude of the mucous membrane near and within the anus; of the laxity of the cellular membrane that binds it to the neighbouring coat of the intestine; of the arrangement of the reverted muscular fibres of the longitudinal plane, playing over the edge of the internal sphincter, as over a pulley; and of the character of the two sphincters, and the manner in which they give support to the lower extremity of the rectum, both when at rest and in motion. Bearing these things in mind, it is easy to perceive the nature and the causes of prolapsus ani. The mucous membrane covering the upper portion of the canal, is always everted, to a certain extent, at every stool, by the longitudinal fibres. Accidental irritation of these fibres increases this effect. In persons of costive habit, the fæces, by their strong friction upon the membrane, urge it still farther forward. Frequent and excessive dilatations of the sphincter internus occasion permanent enlargement of the canal, and diminish the resistance to the eversion. Irritation in the anus, the rectum, or any part of the urinary apparatus, which sympathizes strongly with these parts, increases the evil by producing tenesmus. At length these various causes may so far elongate the cellular attachments of the mucous coat as to permit a circular fold to become permanently loosened, presenting at the orifice of the internal sphincter, provoking frequent and often ineffectual attempts to go to stool, and occasioning habitual distension and still greater loss of tone in the part. If hemorrhoidal, or other tumours are not already formed, they are now extremely apt to appear, in consequence of the embarrassment of the circulation in the part, produced by the pressure of the sphincter on this fold. When present, these tumours tend to promote the progress of the misplacement, for they not only offer additional resistance to the passage of the fæces, but, by becoming entangled in the grasp of the sphincters, they often keep the parts constantly on the stretch.

On its first appearance, prolapsus ani generally presents but a small tumour, surrounding the anus like a ring, during the efforts at stool, and retreating slowly when those efforts cease. It often shows itself at certain periods only, during spells of costiveness or diarrhœa, or during strong and long-continued action of the abdominal muscles; as in severe fits of crying in children, and in protracted or difficult parturition. But if its progress remains unchecked, it soon becomes larger, reappears at every stool, takes the shape of a globular or oblong mass, and no longer retreats by the unaided powers of nature. In this condition, every stool produces an eversion, not only of the mucous membrane of the superior part of the anal canal, but the integuments of the lower portions are also drawn down, the skin around the margin is elongated and loosened, and even when the prolapsed parts are returned, we often find a considerable flap, or ring of redundant skin remaining externally, complicated with irregularities of the canal, and very imperfect action in the sphincters.

The accident occurs much more frequently in childhood and in old age than during the vigour of life. The extent to which the eversion may be carried in extreme cases is prodigious, and it is possible that in old cases, the mucous membrane of the middle or upper part of the rectum may be put upon the stretch, so as to produce invagination of the remaining coats.

Among the occasional causes of prolap-

sus ani, not already pointed out, we may enumerate the use of aloetic purgatives, the too frequent resort to emollient or warm injections, paralysis of the sphincters, and tumours or thickening of the mucous membrane. The symptoms are generally milder than would be inferred from the great tenderness and the important relations of the parts interested, for the prolapsed membrane often bears exposure almost with impunity. In sudden and very considerable eversions, however, severe inflammation, violent pain, and febrile symptoms appear; and when strangulation takes place, the discharge of fæces is arrested, and all the phenomena of strangulated hernia may occur.

When the prolapsus is small and recent, it is returned with ease, and its recurrence may be generally prevented by suitable mild measures; but when it is large, or habitual, it is replaced with greater difficulty, and can be relieved permanently only by surgical treatment of a more serious character. If the cause which excites it is incurable, as sometimes happens when irritations of the prostate gland, bladder, or urethra, produce tenesmus and consequent prolapsus, the ultimate cure is out of the question, and we can only temporize and palliate.

The *treatment of prolapsus ani* has a double purpose; first, the reduction or return of the prolapsed part, and secondly, the prevention of a recurrence of the accident; to which we may perhaps add a third, the removal of the prolapsed part when rendered irreducible.

The *reduction*, when there exists neither strangulation nor inflammation, and when it is not accomplished by assuming a horizontal posture, or by the unaided efforts of the patient, is generally effected with great facility by the surgeon. The patient being placed in bed, with the pelvis raised and the abdominal muscles relaxed as much as possible, the surgeon, if the tumour be quite small, embraces it with the palm of his hand, previously oiled, and makes gentle pressure upon the whole surface, for some minutes, if necessary. The blood accumulated in the tumour is thus gradually driven back into the pelvis, the swelling is diminished, and the reduction is generally accomplished with great ease. There commonly remains, however, some laxity of the integuments about and within the canal; and in order to insure that the last portions of the mucous membrane are returned within the orifice of the internal sphincter, it is advisable to apply the thumbs, or the two indices, to the sides of the anus, so as to press the skin inward, and then, by introducing a well-oiled finger within the rectum, we may remove any folds or irregularities that might otherwise keep the cellular tissue on the stretch, or prove a source of irritation to the rectum. When the tumour is very large, it cannot be returned by so simple a proceeding, and it becomes necessary to roll the prolapsed membrane toward the orifice of the intestine in the middle of the tumour, by means of the fingers; thus gradually reducing the swelling by returning, first, the portions last discharged. In extreme cases, this is often a task of great difficulty; and the inexperienced operator should bear in mind the fact that the membrane may be returned within itself, without entering the canal; or, in other words, that the part of the tube which escapes last, may be folded within the portion which should line the lower part of the rectum, without passing the sphincter; and may thus increase the difficulty of reduction, while the surgeon thinks that he is gaining ground. The efforts at reduction should never be forcible or rough; and while the fingers are employed in involving the tube, it is often proper to keep up a moderate general pressure on the tumour, with the palms of the hands.

If considerable difficulty is experienced in effecting a reduction, some further measures may be proper; as when the bowels have not been evacuated for a considerable time, or when they are known to be in a costive condition, and especially if there is any tenesmus. Under such circumstances, an injection of castor oil occasionally proves highly serviceable, for when the rectum is in action, the presence of firm fæces opposes a powerful barrier against the reduction. When the sphincters are called into spasmodic action, and produce stricture, a free bleeding from the arm may be indicated, if the constitution of the patient will warrant the measure; but one of the most powerful means of combating spasm, is warmth. The warm hip-bath, warm mild poultices and injections, will very generally answer the purpose; but when the spasm is severe and obstinate, opiates should be added to these applications. In cases of actual inflammation of the prolapsed membrane, it is very improper to resort to frequent or strong efforts at reduction; and here it is obvious that the warm applications, even when spasm is present, may become highly injurious. The treatment plainly indicated is the free employment of leeches, and cold poultices, until the swelling and inflammation decline, after which we

should again endeavour to return the protruded membrane. Sometimes the spasm of the sphincter becomes so severe as to close the outlet, not only arresting the fæces, but producing strangulation of the prolapsed membrane, and then all the symptoms and the worst consequences of strangulated hernia may be presented. The same result may occur without spasm, from the mass of the tumour, when swelled by inflammation. In either of these cases the seat of the stricture must be ascertained, and there could be little question as to the propriety of dividing the sphincters, if necessary, by a suitable instrument; but it is well perhaps to remark that in this accident, as in hernia, injury may be frequently done by undue haste. In recent cases, the symptoms are often urgent and require very prompt treatment, but in old habitual prolapsus, the danger of strangulation is seldom imminent. We have returned a most extensive prolapsus, which was in a state of high inflammation and so constricted as to render discharges impossible for three days, without resorting to any unusual measure, and without any serious consequences. The variety of sources, both internal and external, from which the anus receives its supply of arterial blood, and the peculiar arrangement of hemorrhoidal veins, some of which traverse the sphincters, and anastomose externally, tend very greatly to diminish the danger of a total arrest of circulation. When gangrene of the prolapsed part has taken place, the question arises whether the case should be left to the powers of nature or be decided at once by the knife or ligature. The authority of Mr. Samuel Cooper is in favour of the former mode of treatment (*Dict. of Pract. Surg.* Art. *Anus*); but this subject will be more fully discussed when we come to speak of the treatment of irreducible prolapsus ani.

The *prevention of a recurrence of prolapsus ani*, is a department of practice too much neglected by writers. The measures employed for this purpose may be classed naturally under two heads; firstly, the accomplishment of a radical cure by the removal of the causes of the accident, and secondly, the prevention of prolapse by mechanical means, when the causes cannot be removed. The surgeon is culpably negligent of his duty, if, after reducing a prolapsus ani, he fails to inquire into the habitual condition of the bowels of his patient, to ascertain, by inspection if necessary, whether there exists any tumour, ulcer, thickening or irritation in or about the anus, and whether the sphincters are permanently relaxed or dilated; nor is it less important that he should determine the healthy or diseased condition of the urinary and uterine organs. If the rectum is in an irritable condition, as is very generally the case in children labouring under this complaint, the error of regimen, or the diseased action, upon which that irritability depends, should be removed as speedily as possible. In children with prolapsus from this cause, a cure may be effected almost invariably; but in adults, when the accident is produced by rectal irritation, it is too frequently complicated with scirrhus, cancer, or other diseases of the rectum, which, if at all curable, yield only to terrible surgical operations (see *Rectum*), and consequently the radical cure cannot often be attempted with much hope of success. When, however, the irritability of the rectum depends upon ulceration, stricture, spasm, or an invagination, it may be sometimes effectually relieved. If sluggish action of the rectum, or costiveness, be the cause of the prolapsus, the habit must be conquered, if possible; and as the causes of costiveness are very various both in their nature and sphere of action, we cannot pause to consider the measures by which that end is to be accomplished in particular cases. (See *Constipation.*) Dr. Physick has succeeded in some cases in completely curing prolapsus ani by confining his patients exclusively to a diet of rye mush and sugar, and the same remedy has proved equally beneficial in the hands of other practitioners. (Dorsey's *Elements of Surgery.* II. 169.) This sluggishness of the rectum is perhaps the most frequent cause of prolapsus in advanced life.

If any tumours, ulcers, &c., be found in the anus, they should be immediately treated. We shall enlarge upon this subject in the future sections of this article, and in that on hemorrhoids. When the sphincters are found dilated, recourse should be had to the measures pointed out in the section on atony of the anus; but it may be well to remark that the local application of a stream of cold water, by the douche ascendante, or otherwise, so highly useful in this condition of the parts, is also very serviceable in giving tone to those more deeply seated; and wherever the circumstances of the case do not prohibit its employment, it will be found a powerful auxiliary in effecting the radical cure. When the relaxation of the sub-mucous cellular tissue is extended to a considerable distance within the rectum, cold and astringent injections are used with great advantage. Mr. Hey recommends strongly, for this purpose, a decoction of oak

bark, with alum and vinegar. (*Pract. Obs. on Diseases of Lower Intestines.*)

When prolapsus ani has occurred very frequently, and during a course of years, the cellular tissue beneath the mucous membrane and the integuments within and around the anus, become permanently elongated to a great extent, and the slightest causes then suffice to reproduce the accident. Even assuming the erect posture sometimes occasions the prolapse under such circumstances. Constant distension resulting from the presence of the tumour, then destroys the tone of the sphincters, and enlarges and thickens the integuments of the middle and lower portions of the anal canal, which, instead of a simple evolution, such as sometimes occurs in severe tenesmus, or more constantly in recent prolapsus, now undergo an actual inversion. It happens not unfrequently, in such cases, that though the mucous membrane may be returned and retained for a time within the internal sphincter, the inverted integuments below the edge of that muscle cannot be secured in their proper place for an instant, as was very obvious in the first patient upon whom Mr. Hey performed the operation which will be presently noticed. In this state of things, the lower edge of the internal sphincter corresponds nearly or exactly with the margin of the anus, the external sphincter is half dilated, and opposes very imperfectly the tonic contraction of the fibres of the levators, and the anus is placed very much in the situation which it assumes when subjected to an ineffectual effort at stool. The lower portions of the canal no longer exist, and therefore the inverted and enlarged integuments, if replaced at all, must be returned within the superior portion of the canal, where they were never designed to enter, and where their presence would be no more tolerated than would a suppository, or a mass of fæces. The loose flap of integument, therefore, remains hanging around the anus, and the hemispherical eminences seated at the base of the columns of the rectum, as described in the preceding anatomical article, present on the inside of the flap, producing those blue tumours mentioned by Hey and others, as visible externally in such cases. Here it is evident that the surgeon, instead of endeavouring to return the flap, and to support it by mechanical contrivances, should direct his efforts to accomplish a closer adhesion in the subtegumentary cellular tissue in and about the anus, and, moreover, to effect this, if possible, while the margin of the internal sphincter is restored to its proper level and there retained, so that the adhesions may take place while the mutual relations of the parts are correctly preserved. The former of these indications has been explained by several eminent practitioners, and various operations have been devised for its fulfilment; but the latter has been treated with apparent neglect. The earliest notice that we have seen of the plan of removing *portions of the dependent flap* for the avowed purpose of creating adhesions between the integuments and the deeper-seated parts, in order to effect the radical cure of these old cases, is contained in Cheselden's *Anatomy*, though his directions, and his sound pathological reasons for them, have been overlooked by his successors, who have claimed originality for processes not always as well adapted to the end in view. Speaking of the condition just described, Cheselden remarks, "This case I have cured by taking away a piece of the prolapsed gut with a caustic, lengthwise of the gut; the wound discharged the flux of humours, upon which the gut was easily reduced, and cicatrizing in that state, it never more fell down." (*Anat.* ed. 13. p. 158.) Mr. Hey sometimes resorted to a much more formidable operation than that of Cheselden, for the purpose, as he states, of bringing about a firmer adhesion to the surrounding cellular membrane, *and to increase the contraction of the sphincter.* (*Pract. Obs.* &c., ed. 2. p. 438.) This operation consisted in the amputation of the whole dependent flap, or, in other words, the removal of the whole natural lining membrane of the middle and lower portions of the anal canal. In one instance, indeed, he says expressly that he also excised about one-fourth of an inch of the red lining (i. e. *mucous membrane*) of the internal sphincter. He gives five cases, in the first and third of which this operation was performed, and the patients were ultimately cured by it. The only important accidents that resulted from this violent measure were symptoms threatening peritonitis, and returns of the prolapsus, the latter sometimes occasioning great difficulty during the progress of the cure. In the second case, the patient had enlargement of the tubercles of the middle region of the anus; the prolapsus was inconsiderable in extent. The tubercles were removed on one side only, and by the aid of astringent applications, the patient recovered. The fourth case was one in which the inverted mucous membrane had formed extensive adhesion with the external integuments on one side of the anus. At the suggestion of Mr. Lucas, these adhesions were dis-

sected, and the tumour was returned. The patient refused to submit to any further operation, and, although he experienced considerable relief, the radical cure was not accomplished. The fifth and last was that of a lady, who had suffered for many years with a considerable prolapsus, reappearing on the slightest exertion; one of the tubercles was removed on each side, and the cure was so perfect that no further inconvenience was experienced. The first of these cases is dated in the autumn of 1788; the last, in June 1799.

This operation appears to have originated with Mr. Hey. Leonida, according to Ætius, Fabricius ab Aquapendente, and Riolanus the elder, mention the destruction of the prolapsed part by actual cautery, as a means of cure; and Severinus defends it by many observations of his own; while Blegny and Dionis very reasonably contend against it. (Morgagni *De Sed. et Caus. Morb.* ep. xxxiii. art. 2. obs. 10.) There is also an observation of Cowper, in which the prolapsed part mortified and was excised, and the accident occurred no more. (*Anatomy of the Human Body*, 601. t. 39. f. 7.) But these facts do not militate against the claim of Mr. Hey. The operation has been successfully performed in this country by Dr. J. W. Heustis. (*Amer. Journ. Med. Sc.* XI. 411.)

Whately, in a paper published in 1800 (*Med. Facts and Obs.* VIII. 163. Lond.), gives an account of a highly interesting case, which he attended in company with Mr. Cline. Portions of the flap were excised, but the prolapsus still recurred; the operation was again repeated, but the tumour reappeared with the first stool. An attempt was then made to prevent this accident until the parts could cicatrize, by the introduction of a piece of tallow-candle into the anus, but it melted. A portion of a wax-candle was then substituted, but it speedily determined a stool, which of course expelled it, and no benefit resulted. The whole of a wax-candle, secured by a string, was then introduced entirely into the rectum, on the fourth day from the last operation; the bowels were calmed by an opiate, and the string left suspended from the anus; the prolapsus returned no more. The candle was retained five days, and when withdrawn, the wax had disappeared; the wick alone remaining. In 1802, Mr. Howship saw Mr. Heavyside operate by ligature upon a case of piles, complicated with prolapsus; both diseases were relieved by the single operation. Mr. Howship states his belief that the operation for hemorrhoids by ligature will always cure a coexisting prolapsus, if it be rightly conducted, and if the consecutive treatment be properly managed. He advocates the application of a ligature to provoke the adhesion in all cases of prolapsus, and reprobates the use of the knife and scissors, asserting that in his own and Mr. Heavyside's extensive experience he has known the latter to fail, but not the former. Where no piles exist, he recommends taking up a portion of the smooth lining of the anus by the tenaculum, and inclosing it in the ligature. (*Pract. Obs. on Diseases of the Lower Intestines*, ed. 3. p. 163.) Mr. Dupuytren was led by the frequent cure of prolapsus by the excision of piles, to imitate this operation in cases unattended by tumours. Formerly he cut away portions of the inverted mucous membrane, but was deterred from continuing this plan by one case of consequent hemorrhage, and another of obstinate suppuration. He then adopted a different course, which consisted in removing a certain number of the radiating folds of the skin converging to the anus; these he seizes separately, by a ligature forceps somewhat flattened, and then cuts them off from without inward, by a pair of curved scissors. In one case, where the tumour measured ten inches by seven, he succeeded completely by removing six of these folds. (*Journ. Universel des Sciences Médicales.* Sept. 1822.)

The object of all the operations just noticed, is, or should be, one and the same; namely, the creation of a cicatrix or adhesion in the sub-mucous and sub-cutaneous cellular tissue in and about the anus, in order that the retraction or condensation produced thereby may reduce the canal to its natural dimensions, and restore the proper closeness of connexion between the different parts that compose it. In cases where the lining membranes are not unduly extended and thickened, but are simply in a state of habitual relaxation, it is evident that surgical interference should be confined to measures for the production of simple condensation or agglutination of the cellular tissue by adhesion, and all loss of substance beyond what may be absolutely necessary to provoke this adhesion, is not only useless but hurtful, for the healthful play of the various parts composing the anal canal, cannot be disturbed without endangering the occurrence of some of the numerous accidents to which it is liable; and the substitution of a cicatrix for the original integument must interfere with this play. Old, habit-

ual prolapsus of this simple character not unfrequently yields to the treatment already laid down in the earlier part of this article; but, if they resist this treatment, there are other agents at command, by which we may sometimes provoke the required condensation, without resorting to the knife or ligature. An endless variety of tonic or astringent applications have been recommended for this purpose, and among these may be enumerated injections and ablutions of a strong decoction of oak-bark and lime-water, as recommended by Mr. Hey; the application of pledgets wet with a solution of sulphate of zinc, or other mineral astringents, as advised by Mr. Cline (Whately, *op. cit.*); or injections of tonic vegetable decoctions, mingled with spirit of wine, or other direct stimulants, as employed by many practitioners. We have succeeded several times in curing prolapsus which had continued for a considerable period in delicate females, in whom the disease was produced by painful menstruation, by the exhibition of fifteen drops of spiritus terebinthini, given in the usual form of mixture three times a day, and continued for several weeks, the dose being varied in proportion to the effect produced on the bowels, in each individual case.

This remedy produces considerable irritation about the anus, without calling the rectum into strong action; and the irritation is concentrated almost entirely upon the middle and lower part of the anal canal, and the surrounding skin; the very spot where its production is properly indicated. It is advisable to administer it internally, in preference to applying it locally, because it effectually regulates the bowels, thus fulfilling two purposes at the same time. The existence of a purulent or sanguineo-purulent discharge, does not interdict its use, when the constitution of the patient and the absence of other diseases admit it.

When such measures have failed, then, and not till then, the employment of surgical means becomes requisite; but the object, in these simple cases, being merely the creation of adhesion in the relaxed cellular tissue, it would be very wrong to resort to any of the more severe operations enumerated above. We will then consider, firstly, the situation in which the adhesions are required; and secondly, the means of producing them.

The relaxation which produces the accident takes place, originally, at the lower part of the superior portion of the canal, where the reverted longitudinal fibres of Horner exert their action; but it extends itself also to the lower portions of the canal, and the neighbouring surface. While the last-mentioned parts continue displaced, the adhesion of the margin of the mucous membrane to the edge of the internal sphincter, even if it could be effected, would only partially relieve the difficulty, and the advantage gained would be evanescent, because of the absence of the natural support furnished by the lower, to the upper part of the canal. It is, therefore, of the highest importance to effect the required adhesions in the parts below the edge of the internal sphincter. But this is not all; for, if the laxity of the cellular connexions were allowed to continue unaltered in the superior portion of the canal, the original stage of the disease would still continue, and the accident would reappear, upon the recurrence of the causes which first produced it. It is desirable, then, that the adhesions should continue beyond the margin of the internal sphincter; but it is by no means necessary that they should extend far beyond this line; for, if a consecutive prolapsus were to occur higher up in the canal, it would be a proper invagination of the membrane; an accident not likely to occur, unless in some very rare cases of tumour; one which the history of the disease does not lead us to anticipate, and which the natural action of the parts in defecation (see Art. II.) strongly tends to prevent. If it were even desirable to create the adhesions throughout the whole extent of the lax cellular tissue, it would still be scarcely possible; for the relaxation often extends high into the rectum in old cases, and experience proves that when the parts about the middle of the anus are restored to their proper relations, the prolapsus returns no more. So much for the required location of the adhesions: as to the means of producing them by surgical operation, there is a choice. The principle adopted by Cheselden, and mentioned above, is decidedly the best, though his operation admits of improvement. The portion of tegument removed should equal in length the extent of the required adhesions; that is, it should begin upon the skin at a little distance from the margin of the anus, and should terminate upon that part of the mucous membrane, which, when fully reduced, would be applied at, or a little within, the margin of the sphincter; its breadth, in these cases of simple relaxation, cannot well be too narrow; for it is desirable to leave the parts, after the cure, as little as possible embarrassed by cicatrices, or limited by permanent contractions. Cheselden's mode of operating by caustic appears

to have been entirely abandoned, although, in very careful hands, it might, perhaps, prove better in some respects than either the knife or the ligature. The removal of a single slip of integument, as advised by this author, seems to be hardly likely to effect adhesions of sufficient extent, for it is desirable that they should take place round the whole circumference of the canal. The plan of M. Dupuytren is preferable, in this respect, as the length, number, form, and width of the strips removed, are varied according to the exigence of the case; and the bruising produced by the scissors prevents union by the first intention, which is evidently to be avoided in such operations. The method by ligature, as recommended by Mr. Howship, is liable to two very strong objections: firstly, it cannot be employed in such a manner as to act on a long and narrow surface; and secondly, it is intensely painful, for it is absolutely necessary that the ligature should embrace a portion of true skin, and the sensibility of the part is such as to render this agonizing, and almost unendurable (see § 9, on *tumours of anus*). The united testimony of Howship and Heavyside in favour of the universal success of the ligature is, therefore, hardly sufficient ground for recommending this operation; for the duty of the surgeon is not confined to effecting a cure; he is equally bound to effect it in the best manner, with the least inconvenience to his patient. The only advantage possessed by the ligature over the scissors or knife, is the avoidance of all hemorrhage; but in superficial operations upon the lower portions of the anal canal, the danger of considerable hemorrhage is very small, and if it should even occur, it is now commanded with great ease. Even the aid of the speculum ani is not required to detect a bleeding vessel at or below the margin of the internal sphincter. If we might be permitted to throw out a suggestion prompted by the study of the anatomy and physiology of the anus, but the value of which has not yet been practically tested, we would propose, for the relief of these simple cases, an operation unattended with any appreciable loss of substance, while it would secure the required adhesions. It is this: Let two or three simple incisions be made with a small scalpel, on each side of the anus, beginning on the protruded membrane (which, when in situ naturale, lies a little within the sphincter), and terminating on the skin, about half an inch from the margin of the anus. These incisions should be carried completely through the tegumentary membranes, but need not extend beyond them. They should follow the summits, and not the intervals between the radiated folds of the margin, as wounds in the latter situation are very apt to degenerate into troublesome excoriations or ulcers. The edges of each incision should be touched very lightly and quickly with nitrate of silver, so as to secure them against immediate union. This plan would be much less painful, and, if successful, would restore the relative position of the parts more completely than either of those above mentioned.

When prolapsus ani is complicated with tumours, the measures necessary for the removal of those tumours determine adhesions in the neighbouring cellular tissue; and, if proper care is taken before and after the operation, to secure the coaptation of the parts, a radical cure will almost always result: the very strong testimony of Howship alone would be sufficient to warrant this assertion. While speaking of tumours, however, it may be well to remark, that the tubercles so often mentioned by Hey and others, being a natural, and not a morbid appearance as has been supposed (see Art. 1. *Anatomy of the Anus*), do not require removal, unless they are so far enlarged by disease, as to interfere with the proper contraction of the external sphincter; and, in determining the propriety of removing them, we should be careful to distinguish between permanent enlargement, and the mere temporary swelling that occurs from fullness of the vessels during a hemorrhoidal flux, or an embarrassment of the venous circulation of the part by mechanical causes; the former of which can be relieved only by general treatment, and the latter, by replacing the parts, and obviating costiveness, or spasm, if present.

When the constant repetition of the prolapse, and the bulk of the tumour have produced permanent thickening, and actual hypertrophy of the displaced membranes and skin, it becomes absolutely necessary to remove a more or less considerable portion of the lining of the anus, and to make use of the contractile power of the cicatrices, to diminish the diameter of the enlarged canal; else, the sphincters could never recover their proper position, and the radical cure would be out of the question. To accomplish this, perhaps no operation promises so fairly as that employed by Dupuytren, because of the great facility with which the form of the excised parts may be adapted to each particular case. Notwithstanding the very high respect which we always feel for the authority of Mr. Hey, we are compelled, on the present

occasion, to object to his mode of operating, as unphilosophical in principle, and very liable, in many cases, to produce most serious consequences. It is unphilosophical in principle, firstly, because it professes to induce a tonic contraction of the sphincter, by creating adhesions between it and the integument; that is, it requires a cicatrix to perform the function of a muscle; and secondly, because it removes entirely the natural lining of the two lower portions of the anal canal, and substitutes for them, partly a proper mucous membrane not designed to exist in that situation, and partly a cicatrix inclosing the whole circumference of the anus, and incapable of undergoing, without injury, the dilatations necessary in defecation. In proof of its liability to produce serious consequences, we will quote the testimony of one of the fathers of English surgery. CHESELDEN says he saw a case where a bold unthinking surgeon having cut off the prolapsed part, the cicatrix was so hard and contracted that the patient could never go to stool, without a clyster, and then not without great misery. (*Loc. Cit.*) It is singular that Mr. HEY should make no remark on the advice of CHESELDEN, as the work of the latter was in the hands of every student at the period of his studies. Justice, however, demands that it should be remembered that Mr. HEY used this formidable operation only in certain cases; but even in these, the prolapsus was not irreducible; and it is only when the return of the prolapsus is impossible, that we could entertain for a moment the idea of a complete amputation of the tumour.

Prolapsus ani may become irreducible; but we do not consider in this light those cases in which the tumour simply forms adhesions with the surrounding integuments so as to oppose the reduction; as was observed in Mr. HEY's fourth case; for these adhesions may be divided. Nor would we term those cases irreducible, in which the thickened or contracted sphincters prevent the return, for these also may be, and have been, successfully divided. But when the folds of inverted membrane become fused together, or when condensation around the whole margin of the anus opposes the recession of the tumour, it sometimes becomes impossible to return it, even by an operation. In these irreducible cases, the purulent or sanguineo-purulent discharge, so common in old prolapsus, becomes extremely exhausting to the patient, and is, moreover, so horribly disgusting and distressing, that life on such terms is rendered undesirable. Here, if no other measure of relief can be employed, the amputation of the prolapsed part may prove a correct practice in the last resort; it is a situation produced only by culpable neglect on the part of the patient or his surgeon. If the tumour is not very large, the projecting membrane may become changed in structure with time, assuming somewhat the character of the cutis, and becoming invested with a cuticle, according to a well-known law of the animal economy. We have seen one very remarkable case of this character. When such a disposition is displayed by the displaced surface, and the circulation in the part is not threatened, it would be wrong to amputate, particularly as these cases generally occur late in life, when there is no longer occasion for great or dangerous exertion; and the changes should be facilitated by avoiding the use of poultices, and by keeping the part as dry and as much exposed as is consistent with safety and comfort. Among the accidents which may compel us to amputate the prolapsed part, when irreducible, we may mention the occurrence of dangerous hemorrhage from the surface; though this is more likely to happen in recent cases, before the character of the membrane is changed.

Having now completed this rapid view of the various modes of radical cure, it is necessary to add some remarks upon the preparatory and subsequent treatment necessary to give the greatest possible efficiency to our efforts, whatever operation may be preferred. In the first place, it is highly desirable that the anus should remain at rest, during the reunion of the incisions, and, if possible, until the adhesions have acquired some firmness; this requires several days. A week or two before the operation, then, we should exert ourselves to regulate and preserve the natural operations of the bowels, in order to place the part in the most favourable condition. This being accomplished, if the patient's constitution permits, we should place him upon the simplest diet, preferring such viands as are least likely to distend the bowels with fæces; and this diet should be observed, if possible, for a week or two after the operation. On the day of the operation, the rectum should be carefully emptied, some hours beforehand, by means of mild enemata, calculated to act on the lower part of the alimentary canal alone—and about one hour before the performance, a full dose of laudanum, or the acetic tincture of opium, should be given, with a view to arrest the action of the bowels. Opiates should be

occasionally exhibited, after the operation, to prevent any attempt at discharge, so long as the state of the patient and the nature of the diet will permit. The next important matter is to place and keep the parts as nearly as possible in their proper relative position, during the cure. For this purpose, the patient must be placed in the recumbent posture, and ought not to leave it, until the expiration of at least a week, except under urgent necessity. His pelvis and knees should be somewhat elevated, and his shoulders comfortably supported. While in this position, the surgeon should assure himself that the reduction is perfect, and for this purpose, he should introduce his finger, if necessary.

If the parts, from great laxity, are not retainable without assistance, it may be proper to retain them, in the first instance, by a graduated compress, and a crucial bandage secured to a band round the pelvis. The patient must be strictly watched, and if there is a return of prolapsus from any cause, it should be replaced as speedily as possible. This accident is the more unfortunate as it occurs later after the operation. When the patient leaves his bed, the adhesions are not to be considered as having acquired their full firmness, for this requires some time; and the diet and condition of the bowels must be watched with great care, for a longer period.

One more remark in conclusion. The atony of the sphincter externus being habitual in most cases, is not and cannot be cured by the operation, and would, if neglected, lay the foundation of a relapse. It is therefore highly important to invigorate it as speedily as possible, and the local application of cold for this purpose may commence in most cases soon after the operation, before the patient leaves his bed. When he has risen, the stream of cold water, so strongly recommended in the earlier part of this article, should be fully insisted on.

When, in reducible prolapsus, the patient or the surgeon decides against attempting the radical cure by operation, there are still certain mechanical means of support that tend to prevent the frequent return of the protrusion. Some of these are employed internally, and the others externally. The general objection against the former, is the necessity of leaving part of the ligature in the anus to control the body introduced within the rectum, and we know of no apparatus yet contrived that can be allowed to remain during an evacuation, at which time prolapsus is most likely to happen. The oldest of these, and one of the best in principle, was the measure employed by Blegny—who introduced into the rectum, the craw of a turkey, which was then distended with air through a silver tube attached to this membranous bag, and left suspended from the anus. (*L'art de guérir les hernies.* p. ii. s. 2. c. 8.) Callisen (*Syst. Ch.* tom. II.) employed a piece of sponge secured by a silver probe, and introduced into the rectum. Richerand (*Nosogr. Chir.* III. 444.) used a plug of lint inclosed in fine linen and supported by a T bandage, for the same purpose. Dr. Sims recommended a globular ivory pessary (Whately. *Op. Cit.*), and more recently, instruments of the same character, but made of gum elastic, have acquired a reputation in France. All these substances must be evacuated, or withdrawn at nearly every stool although some of them are perforated avowedly for the passage of fæces, and therefore, the disgust of frequent reapplication is superadded to the great uneasiness, and perhaps injury, that their presence in the rectum must produce. Still there is evidence enough to show that they are occasionally serviceable, and possibly some contrivance may be hereafter invented that may cause less inconvenience, and permit of alvine evacuations without requiring a removal. There is much less objection to those dressings that act by giving support externally, and of these, one of the best is the graduated compress and crucial bandage already mentioned, when discussing the proper treatment after operations; for it is scarcely necessary now, to notice the hollow rings, and other similar contrivances recommended by Riolanus, Dionis, Murolt, &c., which have long since disappeared from practice. (See Morgagni. *Epist. Cit.* Art. 8. obs. 7.) Mr. Gooch has published an account, with a figure, of a very well-contrived instrument which he employed with signal advantage in an interesting case. It is a species of truss. The upper part resembles the spring and main strap of a common double truss, wanting the pads, and is designed to embrace the sacrum and the wings of the ilii. Opposite the base of the lumbar vertebra, a curved spring is attached, at right angles, to the upper part, and after following the curve of the sacrum, it terminates in a pad intended to act upon the anus. This gives firm support, and may be turned aside without difficulty when at stool. It may be rendered very secure by scapularies, &c.—and the patient may use exercise, or ride on horseback with perfect safety.

If we have been minute in some of the practical directions just given, it is because

we are firmly persuaded that the want of success in a majority of unfortunate surgical cases results from the neglect of what may be termed by some, petty details of treatment. The minor duties of the surgeon are often quite as important as his more imposing operations.

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See also the General Treatises of HOWSHIP, CALVERT, MAYO, &c., and the General Treatises on Surgery.

§ 6. *Inflammations of the anus.* Both the interior of the anus, and the parts about its margin, are subject to inflammation from various causes. When deeply seated, these inflammations terminate almost invariably in abscess, and we therefore refer the reader to section 13. for further information upon their history and treatment; confining ourselves, at present, to the consideration of such only as have their origin, and, in a great degree, their seat also, in the tegumentary membranes.

The margin of the anus, and the surrounding parts, are very frequently affected with irritation or excoriation, sometimes from the unavoidable attrition of the parts in walking or riding long distances, sometimes from gross want of cleanliness, or from an entanglement of the hairs with which the parts are clothed, and sometimes from the removal of the hair, by the patient or the surgeon. Of irritation from the two former causes it is scarcely necessary to speak; but of that produced by shaving or cutting the hair, we may add one remark with propriety. The skin around the anus is endowed with exquisite sensibility, and cannot endure long-continued motion, even upon itself, without unpleasant consequences. The hair is intended in this, as in many other situations, to prevent the contact of the sides of the nates, and to act like a friction-wheel in machinery, to diminish the attrition. For this reason, it is much more abundant in the male sex, because the anus is much more deeply situated in man. To remove it entirely would, therefore, produce no slight inconvenience; but when cut short, or when, after being shaved, it has again grown to a certain length, it acts like a harsh brush upon the delicate skin, and may produce very severe inflammation. M. VELPEAU states the case of a physician who removed the hair with scissors, and in whom such violent pain and fever followed, that he was compelled to keep his bed for three days. The hair should be removed by the surgeon, therefore, only when there is strong occasion for such a proceeding; and the nates ought then to be kept completely separated by some mild application, until the hair has regained sufficient length and pliancy. The most soothing applications to this kind of irritation, are cold water or cold lead-water, when the cuticle preserves its integrity, and simple ce-

rate or Goulard's cerate, spread upon patent lint, when there is excoriation.

There is a more chronic form of irritation in the same part, which I have never seen distinctly noticed by writers, although in some cases it is a very troublesome and disgusting complaint. It results frequently from culpable want of cleanliness, but it may occur from other less obvious causes. The frequent discharge of stimulating matters from the rectum, particularly in good livers and the intemperate, act upon the surrounding surface, so as to increase very greatly, and also to vitiate, the natural and peculiar secretion with which it is lubricated. The parts are kept continually moistened, and being almost in contact, and protected from exposure, the follicles of the skin enlarge, the cuticle becomes thinner, and the surface takes on something of the mucous character. This is much increased by the external application of mechanical or chemical irritants, and at length the patient is sometimes driven by the great inconvenience it occasions, to consult his surgeon. Not unfrequently the latter seeks in vain for the source of the flow within the anus, when its true seat is entirely external, and may extend over nearly the whole surface of the perineum, particularly in corpulent people. This complaint will generally yield to habits of perfect cleanliness and moderation in diet, aided by daily ablution with cold water, the avoidance of rough or stimulating applications, and, above all, the use of dry lint or linen, applied so as to absorb all moisture, and prevent attrition from the clothing.

The integuments of the interior of the anus are liable to similar irritations from the passage of hardened fæces, or from the vitiated secretions discharged in diarrhœa, dysentery, &c. They are somewhat more grave in character than those which are external, being generally attended with some fever, or glairy, yellow, flocculent discharges, sometimes streaked with blood, tenesmus, constant desire to go to stool, much smarting or burning pain, and a sense of weight, or of the presence of some foreign body in the anus. While inflammation of this character continues simple, that is, when it is not complicated with any previous or consequent organic lesion, it is a slight affection, and easily managed. When the fever is considerable, venesection may be advisable. The diet should be rigorous, and it may be proper, in some cases, to check the movement of the bowels by an opiate. Emollient clysters, and bathing, or the semicupium, are generally productive of relief in a short time. (Velpeau, *Dict. de Médecine*, III. 281.)

Erysipelatous inflammation of the anus is often a very severe and fatal affection. The graver forms of this complaint, those which terminate in suppuration or gangrene, are generally treated of, by authors, under the head of abscess of the anus; but, as they have much less connexion with abscess, properly so called, than with cutaneous inflammation, we prefer noticing them here.

All the forms and complications of erysipelas may affect the vicinity of the anus. The inflammation is often purely local, and occasioned by local irritations to the skin, such as the application of certain stimulating plants, adhesive strips, unguents containing turpentine, &c. In other cases, erratic erysipelas, while traversing other parts of the body, invades the anus also. Sometimes the disease is confined entirely to the skin; at others, it is complicated with diffuse inflammation of the cellular tissue, producing the varieties formerly termed erysipelas phlegmonoides, and erysipelas œdematodes.

The inconveniences and dangers attendant upon this complaint, when situated as described, result chiefly from the extensive associated actions or sympathies of the part, and from the peculiar structure and abundance of the cellular tissue of the region. In all cases, the constitutional symptoms are much more severe than the mere extent and gravity of the inflammation would lead us to expect: still, there is nothing absolutely peculiar in the nature or consequences of the disease when thus located; and the reader is therefore referred to the article on *Erysipelas*, and that on *Cellular Inflammation*, for all discussions of the general principles of treatment. Our remarks will be confined, in this place, to a few specialities.

When the inflammation is simple, or confined entirely to the skin, as is generally the case where there exists no epidemic tendency to erysipelas and its congeners, and when the patient's constitution has not been undermined; the fever may run high, the redness and swelling of the part may be considerable, the colour tolerably bright, and the burning pain severe, from the first. Such cases, if treated promptly, are seldom dangerous, and do not strongly tend to suppuration. Although general bleeding is by no means so extensively employed in erysipelatous, as in phlegmonous inflammations, yet in cases where there are no strong symptoms of collapse, it is often advisable; and, from

the extensive sympathies of the part affected, it may be strongly indicated in the sporadic form of the disease in question. Local bleeding, by means of leeches, is of more doubtful propriety, as the irritation produced by the bites of these animals not unfrequently produces erysipelatous inflammation. As this is seldom the case, however, when there exists no epidemic tendency to diffuse inflammation of the cellular tissue, the employment of leeches may not be always contra-indicated in severe sporadic cases. The local applications which give the greatest relief to the burning pain and the irritative fever, are the strong aqueous solution of opium, and the solution of acetate of lead; the former acts most agreeably in the generality of cases, but, in some few patients, all applications of opium to the skin, in erysipelas, prove highly irritating. The use of mercurial ointment and other unguents, so strongly recommended by some, has disappointed us even in other forms of the disease; but when the neighbourhood of the anus, or any other place where the skin approaches towards the character of mucous membrane, is attacked, we have sometimes found such remedies productive of peculiarly unpleasant effects, either by increasing the local pain, or by inducing unexpected salivation. Blisters, so strongly recommended by Dr. Physick, in erysipelas of other parts, have seldom been employed in this situation; but there exists no strong objection to their use, when they seem to be indicated.

The inflammation, in cases of this character, affects the middle, as well as the lower portion of the anal canal, being coextensive with the cutis proper, and hence discharges are productive of much pain and inconvenience. When the diseased action extends to the cellular tissue, taking the form of the diffused cellular inflammation of Duncan (*Edinb. Medico-Chirurg. Trans.* I. 470.), the symptoms are much more severe, the treatment more difficult, and the termination too frequently fatal. Persons who indulge to excess in eating or drinking are most obnoxious to this affection. It may occur at any time, but the liability to it is greatly increased when an epidemic tendency to erysipelas and its congeners is prevalent. In this form of the complaint, the affection of the skin becomes a matter of secondary importance, the danger of extensive suppuration and gangrene of the cellular tissue and fasciæ being infinitely more terrible. Indeed, this is by no means a local disease of the anus, or even of the integuments in general. In whatever manner and situation the irritation which proves its exciting cause may act; whether it be in a fractured limb; in a punctured wound; from the application of a poisonous substance, stimulating dressings, or vitiated secretions; the collapse, in the graver cases, and the irritative fever, in those which are less severe, are much more strongly marked than the local mischief in the first stage would lead us to expect; and it is very certain that the condition of the hepatic functions is much disturbed after the access, if, indeed, the liability to this species of inflammation does not result, primarily, from the effect of intemperance, or the epidemic cause, upon the hepatic organs. The local treatment of the disease is, therefore, not more important than the general treatment.

When it occurs in the neighbourhood of the anus, diffuse inflammation of the cellular tissue generally results from the irritation of vitiated discharges, or from slight injuries produced by the passage of hardened fæces; strangulation of a hemorrhoidal tumour has been known to produce it; and, indeed, any injury to a vein would be very likely to prove an exciting cause, as the common operation of venesection so often occasions it in the arm, and as the disease is frequently complicated with, or mistaken for phlebitis. (See Duncan, *loc. cit.* and Earle, *Clinical Lecture on Cellular Inflammation—London Med. and Phys. Journ.* Jan. 1827.)

The attack is often marked by nausea, slight chilliness, and the other marks of the cold stage of fever. A swelling is then perceived around the margin of the anus, and the skin is more or less changed in hue,—sometimes it is yellow, at others red, dusky or purple; but the appearance of the skin is no certain index of the severity or extent of the affection. The tumour lacks the hardness of a phlegmonous inflammation; and, although the outline of the disease may be clearly defined upon the skin, the swelling beneath cannot be precisely traced. The pulse is generally frequent, hard, contracted, and jarring, at first; but it soon becomes weak, low, fluttering, or irregular; there is great restlessness, anxiety, often nervous agitation, and the patient complains of great pain and uneasiness, although the part is not generally very tender to the touch. The secretions are, for the most part, vitiated or arrested, and the bowels are commonly bound. The swelling extends itself with great rapidity on every side, toward the nates, the back, and the perineum; but it soon loses its firmness, and assumes more or less of that peculiar doughy or

boggy feel which characterizes the diffuse cellular inflammation in other places. The disease advances with alarming speed, and unless very promptly treated, it ends in gangrene of the cellular tissue, to an extent that cannot be foreseen.

On the first attack of this complaint, when the colour of the skin is not very dark, and while the pulse retains its increased action, venesection may be proper in some cases; but when the depression of the system is considerable, it is obviously improper. Local bleeding by leeches would doubtless prove serviceable in the forming stage, were it not that the bites of these animals are particularly prone to produce or increase erysipelatous disease; and it is, therefore, advisable to be cautious in their employment, when the epidemic tendency, already mentioned is prevalent.

Percival Pott, who dwells particularly on this affection, directs early and free openings to be made in cases of this character, without waiting for obvious deposits of pus. (*Chirurgical Works*, Lawrence's ed. III. 91.) The plan of free incisions in the treatment of diffuse cellular inflammations, generally introduced by Mr. Copeland Hutchinson, and strongly advocated by several eminent British surgeons, is more decidedly applicable in those cases that affect the neighbourhood of the anus, than in any others. The plan has been discountenanced on this side of the Atlantic, in consequence of its apparent severity; how justly, in other cases, we shall not now pause to consider; but in those of the anus, the dangers are so imminent, that severity can hardly be alleged as an argument against a remedy, otherwise advisable. It should be remembered, that if we wait for the formation of matter, we wait also for the occurrence of sloughs, which are generally extensive in proportion to the looseness of the cellular texture of the part. The testimony of Mr. Earle goes to show, that when the incisions are made before any pus is formed, and when the hemorrhage is promoted by warm fomentations, the inflammation is greatly diminished, and the case may terminate favourably in a few hours. (*Loc. cit.*) A mild poultice should be placed on the part, after the incisions are completed.

With regard to the general treatment of diffuse cellular inflammations, there are wide differences of opinion; and, as Duncan acknowledges, the practice is still unsettled. The older authorities, like Pott, advocated a highly stimulating treatment, as in other gangrenous cases. Duncan decides in general in favour of a mild depletory course. Mr. Earle directs that, immediately after the incisions are dressed with the poultice, the patient should take a large dose of calomel and antimony; and, after some hours, a free purge of senna and salts. Whatever may be thought of these last-mentioned directions in ordinary cases, they are obviously inapplicable where the disease attacks the anus. We are informed that in the practice of the Pennsylvania Hospital at present, the general treatment, in most cases of diffuse inflammation from wounds and fractures, is confined mainly to supporting the patient by a mild but nutritive diet, and to the use of diffusible stimuli in cases of great depression; and the results of numerous cases show a remarkable degree of success. We have reaped great advantage, in many instances, from the employment of small doses of calomel, as laxatives, repeated every day, or every other day, so as to promote a healthy action of the liver; and whenever we have resorted to more powerful purgatives, the effect has been, we think, injurious. There is nothing in this course calculated to do injury, when the seat of the disease is in the neighbourhood of the anus; and we have, accordingly, employed it in two cases which have come under our observation.

When the colour of the skin is dusky or purplish-red; when it has a doughy, unresisting feel, and but little sensibility; when the pulse is unequal or faltering, and there are irregular chills and shivering, great debility and mental depression, or stupor; the case, says Mr. Pott, is generally fatal. Evacuations, in such cases, are out of the question: and it is remarkable, that this very eminent practitioner here declares that "large and deep incisions should be made into the diseased parts." (*Op. cit.* p. 92.)

Sir Astley Cooper observes in his clinical lectures, that immense losses of substance from gangrene of the anus, often recover with very little difficulty; and there are several astonishing instances of this kind on record. Three cases of entire destruction of the soft parts around the anus have occurred within a few months at the Pennsylvania Hospital. In one, a female, the disease involved the labia pudendi, and terminated fatally: the others were male patients, and recovered. The cicatrices produced much deformity by their contraction, which distorted the scrotum and perineum, but did not materially embarrass the functions of the anus. The much-vaunted kreosote was employed in one of these cases, with some advantage;

but its principal effect was the destruction of the fetor of the diseased or destroyed parts. (*Am. Journ. Med. Sc.* XV. 355.)

When this species of inflammation is extended to the nates, where the cellular tissue becomes more fibrous, and is loaded with adipose matter, an imperfect attempt is often made to limit the extension of the disease; one or more ill-defined tumours are formed, and present an appearance resembling in some degree an anthrax.

Diffuse inflammation of the cellular tissue about the anus, ending in sloughs, is readily distinguished from those cases of gangrene in the same parts caused by tearing the rectum or injury of the urinary organs, followed by the infiltration of urine or irritating fæcal matter.

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§ 7. *Blenorrhagia of the Anus.* We have spoken, in the previous section, of increased and vitiated secretions produced by habitual irritation of the lower portions of the anal canal. Inflammations of all parts of the anus may produce corresponding discharges of a mucous or ichorous character, and sometimes genuine pus is plentifully evacuated while there exists no abrasion of the surface, and no ulcer, or other breach of continuity.

A discharge of either kind from the anus itself may be distinguished from the same species of evacuation from disease in other parts of the alimentary tube, by the unmixed character of the pus, its more uniform flow, the great sensibility of the part, and in general, by the colour and obvious inflammatory swelling of the integuments within and around the orifice.

Even when the discharge is purulent, and when there is no breach of the integuments of the part to account for its appearance, it will not do to attribute it invariably to a specific cause; we have seen at least one strongly marked case, in which the correctness of the habits of the patient was beyond question. Yet, in a large majority of instances, blenorrhagia of the anus is doubtless the result of a direct contact with urethral gonorrhœal matter. The amount of the discharge is sometimes very great, and the irritation so high as to produce even violent fever, during the early stage. It is well known that gonorrhœa occasionally becomes extended over the glans penis and the prepuce, and M. Velpeau remarks that he has seen the discharge, in that form of the disease of which we are speaking, not only about the margin of the anus, but over the surface of the perineum, between the scrotum and thighs, and even toward the coccyx. (*Dict. de Méd.* edit. 2. III. 285.)

The treatment of blenorrhagia of the anus should be conducted upon the same general principles which govern us in that of the urethra; but the effect of injections is less likely to prove dangerous here, because the parts interested are not so liable to organic stricture, nor is there so much danger of swelled testicle when the flow is suddenly arrested. The febrile symptoms running much higher when the disease attacks the anus than when it is confined to the urethra, it is often necessary to carry venesection and the antiphlogistic treatment much farther—having due regard, however, to the temperament and general condition of the patient. When these means are properly employed, and aided, if necessary, by opiates to obviate the terrible pain of the alvine evacuations, or the spasm of the sphincters, with which the case is sometimes complicated, we may occasionally succeed in arresting the disease, very early in its course, without any farther measures. In the case of a young gentleman in whom an accidental contact of pus from the urethra, produced the most violent symptoms, such as even threatened life, the sphincter internus was affected with frequent and long-continued spasms for several days, an internal hemorrhoidal tumour became engaged in the stricture and lost its vitality. The discharge in this case was prodigious, but after four free bleedings, and the application of cool poultices, the inflammatory symptoms completely subsided. Under this treatment, aided by forty drops of the acetic tincture of opium, given as occasion required, the violence of the spasms was also controlled; and after the separation of the slough, no farther inconvenience was experienced, except from

the urethral discharge, which soon after yielded to injections of sulphate of copper. In a milder case we reaped considerable advantage from the employment of injections of the mucilage of the pith of sassafras during the height of the inflammation, this being at once the most soothing, the most evenly diffusible, and the most elegant of this class of preparations.

When the discharge continues after the violent symptoms have subsided, recourse is had to injections similar to those used for the urethra. M. Velpeau makes the following practical remarks: "A mixture of Howard's calomel (*cal. à la vapeur*) and the decoction of marsh mallows, in the proportion of ʒi. of the former to ℥i. of the latter, injected into the anus by means of a small syringe, proves generally successful. The same substance, or the white precipitate, made into an ointment in the proportion of ʒi. to ℥i. of unction, is equally efficacious. These two applications appear to me decidedly superior in effect to the solutions of sulphates of zinc, alumine, iron, or copper, and even to that of the deuto-chloride of mercury, when semicupia, emollient medications, and the ordinary means of cleanliness have failed. Fomentations are always indispensable adjuvants, and it is necessary to prevent the contact of the parts by the application of lint or rags frequently replaced, in the diseased excavations," (i. e. *in the fossa about the perineum and between the folds of the skin*). (*Loc. Cit.*)

This form of disease of the anus is rare in America. In the few cases subjected to our observation, in which the complaint has not yielded to cleanliness and the depletory treatment, we have succeeded by using the solution of sulphate of copper added to the mucilaginous injection, at first in the proportion of a grain to the ounce, and the strength gradually increased until the discharge was arrested. Compresses imbued with the same solution should be applied externally as extensively as circumstances require.

§ 8. *Organic Stricture of the Anus.* Whatever tends to excite inflammation of the lining membrane of the anus or rectum may produce organic stricture; but we shall confine our observations in this place chiefly to those cases in which the disease commences in the anus, referring the reader to the article on the pathology of the rectum for information on the various forms of the complaint in which the latter part becomes affected consecutively; as in carcinoma, invaginations, and habitual torpor of the great intestines. As many of the acknowledged causes of strictures of the anus; such as inflammation induced by dysenteric discharges, or cholera; syphilitic complaints, primary or secondary; obstinate constipation, and the consequent passage of hardened fæces; &c.—are even more frequently productive of coarctations higher up in the canal; and as the rational signs of these several kinds of stricture rarely furnish sufficiently strong diagnostic marks, without the aid of examinations per anum, we must refer to the article just mentioned for these signs also—contenting ourselves at present with a view of the causes and treatment of the local symptoms obvious to the senses.

One of the most common forms of stricture of the anus, is situated near the upper margin of the internal sphincter, and results from plastic inflammation of that part. Mr. Charles Bell gives the following description of the mode of its formation. "The third kind of stricture of the anus is the true stricture, what is meant by *common scirrhus*, ascertained first by feeling of it, and then by the exact place of it. Have you never asked yourselves why it is that stricture of the rectum is so exactly situated, so that when you introduce the finger to examine the part, you find that the finger passes up to the second joint, before you can feel the contraction? You have the answer in the anatomy of the part; the stricture takes place at the margin of the internal sphincter ani muscle, which is often occasioned in this way: by habitual constipation a great straining sometimes takes place, but the intestines become sluggish, refuse to act; and if the intestines do not act, neither will the sphincter give way, for the sphincter and the muscles of the intestines are always alternating in their action; when the one acts the other yields, so that the person straining at stool propels the feculent matter toward the anus, and a fold of the inner membrane of the rectum is pushed down directly opposite the internal sphincter, and this continuing for a time, a fold of the intestine falls across the canal at that part, and you feel it there." (*Clinical Lecture. Lancet*, No. 105.) This fold spoken of by Mr. Bell, becomes indurated by the interstitial deposit of coagulable lymph, and it may also form adhesions by an exudation of the same substance upon its surface.

This form of stricture resembles that of the urethra, and requires the same mode of local treatment. It is one of those cases in which the happiest results may be

expected from the judicious employment of the bougie. But it would be very unwise to attempt the cure of the stricture without the removal of the causes which first produced it; these may be, either deficient action of the bowels from improper diet, or nervous debility (see *Constipation*), —stricture, or invagination, and the consequent accumulation of fæces higher up in the canal (see *Rectum*, *Colon*),—disease of the uterine, or urinary apparatus (see *Prostate Gland*, *Uterus*), or that hyperaction of the sphincter mentioned by Delpech, Boyer, and others, of which we have spoken in the section on spasm of the anus. (q. v.) While speaking of this form of stricture, it may be well to mention that it is sometimes complicated with false membranes thrown out upon the surface, so as to form partial septa or fillets across the canal, such as are noticed by Ruish, Morgagni, Boyer, Copeland, &c. (See *Rectum.*) When these occur in or near the anus, they are easily destroyed by the bougie; and, as they are very extensible in their nature, they may not afterwards limit the motions of the part. The great evil they produce, so long as any traces of them remain, is their constant liability to renew the adhesions. Blood generally follows their rupture, which proves that they have become organized.

In many cases of contracted anus, says Calvert, there is merely a thickening and consolidation of the fine skin of this part, and of the adjacent cellular membrane, without any disposition to spasm or to specific structural disease. This, at first, does not occasion much inconvenience, except during a dry and constipated state of the bowels, when some degree of pain and difficulty is felt in passing a hardened motion, more, perhaps, in consequence of the parts about the orifice of the gut not being as susceptible of dilatation as usual, than from any absolute contraction. If the complaint continue for some time, it is usually followed by a slight degree of prolapsus ani, the necessary consequence of straining at stool, by which the inner membrane is gorged with blood, and being elongated, is forced down, whilst the fibres of the sphincter muscles being continually exerted, as if some foreign body were accidentally lodged in the same part, by degrees become morbidly contracted, and add very considerably to the straightness of the passage. (*Practical Treatise on Hæmorrhoids*, &c. p. 204.) This form of stricture may result from any cause of chronic irritation, and is not unfrequently observed in persons who have been long subject to hemorrhoidal disease. It generally gives rise to but little inconvenience, if proper attention is paid, in the early stage, to the habitual condition of the bowels, and to the diet of the patient. If neglected, however, it may at length become a cause of great evils; for the elasticity of the skin is sometimes so completely lost, that crevices are formed by the distension of the canal, giving rise to great pain and refractory ulcerations, and it may become necessary to resort to severe surgical measures for their relief. (See § 10.) In some cases the sphincter externus, constantly irritated by these crevices or sores, becomes permanently contracted by a deposition of lymph within its substance, destroying in great degree its functions; a complete division of this muscle then becomes necessary.

There is a form of stricture mentioned by Mr. Charles Bell (*loc. cit.*), in which the deposit of lymph takes place chiefly around the margin of the anus, causing a contraction of the integuments like that which we sometimes see in the mouth, and which there proves so exceedingly intractable. This stricture is sometimes so great as to prevent any body larger than a goose-quill from being introduced. For the relief of this most unhappy state of things, the knife is indispensable. Mr. Bell recommends that, in this case, a piece of thin cloth should be spread over the anus, its centre carried up into the rectum upon the point of a probe, and the sac thus formed gradually filled with lint, until the lower part of the rectum is distended. Then, using the neck of the sac of cloth as a handle, he directs it to be drawn down so as to make the anus very prominent. A circular piece, including the stricture, is then to be removed by a single sweep of the knife, cutting upon the sac. This operation is essentially the same with that of White for obstinate prolapsus ani, and is liable to the same objections. (See § 5.) Nor can we perceive the necessity of the proceeding; for, in the worst cases of stricture of the mouth, we do not pretend to excise the whole mass of the diseased structure. This variety of the disease must be very rare: we have never seen it, but should certainly feel better disposed to trust for success to the deep lateral incisions recommended by Delpech in the worst forms of stricture from primary or secondary syphilis, and even in the still more unhappy cases of great contraction from cicatrices. If, in any form of stricture not connected with a disease necessarily fatal, all other means, such as the

regulation of food and laxatives, the cautious use of bougies, the lateral incisions, &c., should have failed, and if we have no other prospect than death by obstruction, or a severe operation with a probability of consequent weakness of the most disgusting kind, we might be induced, indeed, to consider the propriety of converting the natural anus into an artificial one,—for there is ample evidence to show that life is not sacrificed by the excision of the lower part of the rectum (see *Rectum*), and Nature has even been known to resort to an analogous process for her relief in complete stricture, choosing the location with even less judgment. But, in such circumstances, we should not be content with the excision of the integuments alone, unless, indeed, the stricture be confined absolutely to the proper skin of the lowest portion of the anal canal; for, in this case, it would scarcely differ from a simple excrescence of the part, and might be treated by excision without danger. The result of the cases of diffuse inflammation of the cellular tissue around the anus, and external to the sphincters, proves that the contraction of circular cicatrices in this situation, does not very seriously embarrass the functions of the canal. (See § 6.)

In olden time, when the integuments and other indurated parts were freely removed in all cases of abscess and fistula about the anus, from mistaken pathological opinions, it was much more common than at present to see strictures of this canal from the contraction of cicatrices: we have quoted a case in point from Cheselden, when speaking of prolapsus ani,—but as we have seen in the last paragraph that some surgeons still treat the destruction of integuments in this neighbourhood with less caution than we should feel, it may be proper to add a few remarks of the justly celebrated professor of Montpellier on this subject. "In fine," says Delpech, "it happens, that in cases of habitual engorgement and eversion of the internal membrane of the anus, in consequence of the presence of hemorrhoids, in attempting the excision of the scroll (*i. e.* the lateral tumours formed by this slight shade of prolapsus), which sometimes occasions insupportable inconvenience, the surgeon has extended the operation to the whole circumference of the anus. In these cases, it has frequently resulted from this practice, that the circular cicatrix has contracted the natural passage, and rendered it almost incapable of performing its functions. Experience has proved that in this state of things, the use of dilating instruments is rarely serviceable, and is often productive of intolerable pain. But advantage has often been derived from making one or two incisions on the circumference of the anus, in such a manner as to divide perpendicularly the whole thickness of the cicatrix, and penetrate into the subjacent parts. It is then possible to introduce a plug of lint; and the interposition of this foreign body during the cicatrization of the incision, is sufficient to maintain the free exercise of the functions of the anus." (I. 597.)

There are two forms of stricture of the anus resulting from disorganization of the lining membrane, and differing in this respect from the simple thickening and callosity produced by the deposition of lymph, or, to speak more properly, by adhesions within the skin and cellular tissue, as noticed in the last variety. Both these forms are attended with considerable irregularities of surface, at least in their mature stage; and, in both, the disease extends to the rectum, or may, perhaps, originate in that viscus. The first of these forms is considered as syphilitic. It makes its approach very slowly, and produces thickening, often of a cartilaginous firmness, which sometimes surrounds the canal entirely, and, in other cases, forms congeries of small tubercles, encroaching more or less upon the canal. It is very rarely attended by distinct ulcerations. M. Delpech considers it as a secondary consequence of the venereal disease, and states that it yields to the local and general treatment adapted to that complaint. (*Op. cit.* p. 591.) The other form is produced by scirrhus of the rectum, in which the anus, generally, but not invariably, becomes interested consecutively. Both the diagnosis and treatment of these affections are unsettled and difficult, and they will be more properly considered in detail in the article on the rectum. Obstructions of the anus from hemorrhoidal and other tumours, venereal excrescences, &c., will be spoken of under the appropriate heads.

We will close this section with these general remarks: The treatment of all the varieties of organic stricture of the anus, requires the most careful attention to the diet and habits of the patient; the avoidance or removal of all causes of local irritation; the arrest of the inflammatory symptoms, when present, by appropriate measures; the cautious use of distending instruments, and, as a last resort, the enlargement of the canal by incisions. Of the use of bougies, it should be remarked,

that they should never be very hard, and that distension should be effected very gradually. Neglect of this precaution may even occasion fatal peritonitis. (Vide C. Bell. *Loc. Cit.*) Incisions produce permanent relief in most cases, but not so complete as to prevent the necessity of constant attention to diet and regimen, and this is particularly the case in stricture from eschars after a loss of substance. It is too much to expect the parts in these cases to recover their functions perfectly. In the scirrho-contracted variety the disease is of course incurable, but even here, incisions have prolonged life for a considerable time. (See *Rectum.*)

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§ 9. *Tumours of the Anus.* The anus and its vicinity are liable to a great variety of tumours, vegetations and excrescences, as scirrhus, condyloma, steatoma, varix, &c., none of which are absolutely peculiar to these parts, except the hemorrhoidal enlargement. (See *Hemorrhoids.*) It is unnecessary here to enter into any details respecting them; and we shall therefore confine ourselves to some general remarks upon the cautions necessary in the removal of these encumbrances by surgical operations. The knife and the ligature have both been resorted to for this purpose, and each has its advocates. The objection urged to the former is the danger of hemorrhage; to the latter, the pain it causes.

The two lower portions of the anal canal may be inspected completely without the aid of instruments; the blood-vessels in this part are inconsiderable, and if divided may be taken up without difficulty. In the superior portion of the canal the vessels become larger, but as the surface may still be inspected by the aid of a proper speculum, vessels near the margin of the internal sphincter may be tied, if necessary, with a little dexterity; but those which lie deeper, toward the superior margin of the muscle, cannot always be controlled with certainty, until the sphincter is divided, so as to admit of great dilatation. Again; if secondary hemorrhage should take place in the middle or in the lower region of the anus, it would become immediately obvious externally, and could be repressed very readily, when occurring in the latter locality, and without much difficulty, in the former; but when the same accident happens in the superior region, the blood sometimes flows back into the rectum, and accumulates there to a great extent, so as to exhaust the strength of the patient, before he or the surgeon becomes aware of the fact, as was the case in one of the operations for irreducible prolapsus performed by White. (See § 5.) Hemorrhage of this character may indeed be checked by compresses in some cases, but it requires considerable skill to accomplish the purpose, and sometimes it is absolutely necessary to relinquish it, and arrest the bleeding by cautery or by applying a ligature to the vessels.

There can be little question then, of the propriety of employing the knife in all tumours situated below the margin of the internal sphincter. But in many of those attached altogether above this spot, the danger of hemorrhage, and the inferior sensibility of this part, furnish, we conceive, solid reasons for preferring the ligature, provided there is nothing in the firmness or condition of the tumours to interdict its use.

It is more difficult to decide upon the best mode of removing tumours having extensive connexions both above and below the margin of the muscle, and consequently covered partly by mucous membrane and partly by external integument, owing to the danger of hemorrhage if the knife be used, and the intolerable pain and serious nervous irritation produced by the ligature from its action on the lower portion. Dr. Physick has devised a peculiar method of operating, which, whilst it is secure from all danger of hemorrhage, removes, he thinks, the grave objection to the employment of ligatures. It consists in completely dividing the skin around the base of the tumour with a scalpel, carrying the incision from the edge of the mucous membrane on one side to the same level on the other, giving it such a direction that when the whole tumour is afterwards embraced in the loup, the ligature may traverse the incision, so as to act, when tightened, upon the subcutaneous cellular tissue and the mucous membrane without in-

cluding any portion of the skin. When it is impossible to embrace the whole tumour in one or more ligatures, there is no longer a choice of measures, and if any operation is admissible, the knife must be used without reference to the location. When rapid and alarming hemorrhage takes place, the bleeding vessels must be tied or cauterized, and if necessary, the sphincters may be divided to facilitate their discovery. When the hemorrhage occurs from small vessels even above the anus, in the lower part of the rectum, it may be arrested in many cases by compresses introduced into that intestine. The following mode of forming such compresses has been employed by Dr. J. R. Barton of Philadelphia. Take a sufficient number of pledgets, made from portions of a common roller bandage, or other piece of muslin, about two inches in width, and long enough, when loosely wound, to gain ready admittance into the rectum. Let each pledget be secured by a ligature tied round the middle of the roll, and long enough to leave several inches of the ligature freely dependent from the anus. Introduce these pledgets, previously thoroughly oiled, one after another, into the rectum, until the lower part of that viscus is distended by the muslin, leaving the free ends of the ligatures hanging from the anus. This being done, divide the projecting ends of the ligatures, carrying one half their number toward the right hip and the other half toward the left; then take a larger pledget or small roller, firmly wound, and place it between the parted ligatures, with its axis in the antero-posterior direction; lastly, gather the ligatures from the opposite sides of the anus, and tie them across the external pledget with sufficient firmness to arrest the hemorrhage. The great objection to this apparatus is that its presence in the rectum is tolerated with great difficulty. M. Dupuytren once succeeded in arresting a hemorrhage of this kind by introducing into the intestine a pig's bladder, afterwards stuffing it with lint; but he found even this apparatus insecure, because it was almost always discharged involuntarily by the action it excited in the rectum (*Leçons Orales.* I. 353.); and the same objection exists to sponge and other compresses, though they prove useful in some cases. This surgeon relies mainly on the actual cautery in grave cases, but his remarks are applied more particularly to the consequences of operations on some forms of *hemorrhoids* (q. v.). Hemorrhages of a less alarming character may be relieved by cold injections, a proper attention to position, and keeping the patient cool. The whole subject of hemorrhage from the anus will be more fully discussed in the article on *Hemorrhoids.*

§ 10. *Ulcers of the Anus.* Ulcers occur in the anus from a great variety of causes, such as mechanical injuries from the introduction of instruments, or the passage of hardened fæces or foreign bodies taken into the stomach; the contact of venereal virus; unnatural crimes; unusual and too rapid distension; the engagement of fæces in the mucous follicles and their consequent enlargement; &c. From whatever cause these ulcers may result, they not unfrequently produce severe suffering and prove very unmanageable. Some of the principal difficulties in the treatment are occasioned by the radiated duplicatures of the skin in the lower part of the canal, the excavation of its middle portion, and the disposition to form circular folds in the upper division. These irregularities often conceal portions of the sore, and make it difficult to apply remedies to the whole surface; they even give a characteristic form to most of the ulcers in the different regions just mentioned. Thus, below the sphincters, ulcers are generally lineal and concealed in the radiated folds; between the sphincters, they sometimes exhibit the same form, particularly when they result from distension; but more generally, they spread and involve a considerable portion of the surface of the enlargement noticed in that part of the canal; above the margin of the internal sphincter, on the contrary, they commonly extend most rapidly in the circular direction.

Still graver embarrassment is occasioned by the great mobility of the part, and the absolute necessity for the frequent exercise of its proper functions. Bearing these facts in mind, and recollecting the peculiar action of the sphincters in restricting the freedom of circulation in the veins of the part, it is easy to understand how far the treatment of ulcers of this part must differ from that of similar affections of other places. Before proceeding to notice the several forms of ulceration, it may be proper to remark that they all require such a course of diet and occasional gentle aperients as are calculated to diminish the quantity and the consistence of the discharges, so as to secure the most perfect repose of the parts which the nature of the case and the condition of the patient will permit. When irritation

runs high, local bleeding, emollient poultices, and small mucilaginous injections, are advisable, provided they do not interfere with the application of other necessary topical remedies.

a. *Ulceration from mechanical injury.* Under this head may be included such abrasions and lacerations as are produced by over-distension, or by the passage of hardened fæces, as well as those which follow surgical operations, and the careless employment of instruments.

In cases of habitual costiveness, the hardened contents of the rectum occasion great friction upon the mucous membrane, particularly near the margin of the internal sphincter, and this sometimes produces a transverse laceration of greater or less extent. The patient is generally conscious of the accident at the moment of its occurrence; a sense of tearing, and sometimes an acute pain in the part, is superadded upon the soreness usually felt on going to stool. If application is made to the surgeon immediately, which is unfortunately but seldom the case, the cure may be effected in a very short time, simply by the exhibition of repeated warm injections so as to secure the daily evacuation of the rectum, without straining, and by confining the patient to a fluid diet. But when neglected for a few days, this laceration becomes a confirmed ulcer; great pain is experienced, particularly at the time of a stool; a discharge of mucus, pus, and occasionally blood, is established, and the ulcerated surface may be felt by the finger introduced into the anus. The complaint, in most instances, may still be cured by attention to the directions just noticed, aided by suppositories of opium, or belladonna, for the relief of the pain. Sometimes the application of mild mercurial ointment, or lunar caustic, pure, or diluted with an ointment, has proved highly serviceable, and it may be made without much difficulty by the aid of the speculum. If inflammation runs high, leeches within the margin may be employed. When the disease proves inveterate and there is danger of complete perforation of the intestine, or when the constitutional symptoms are alarming, it may become necessary to divide the sphincters by the bistoury, in order to remove the repeated straining of the part in the performance of the necessary functions.

When the cutis gives way in consequence of too great or too sudden distension of the lower portions of the canal, the crevice takes a longitudinal direction, and is very frequently concealed in the longitudinal or radiated folds of the part. The natural secretions and impurities keep the opening continually moistened, and generally, by irritating matters; so that immediate reunion is effected with difficulty, and when it fails, the frequent motions produced by the passage of fæces lessen very greatly the chances of a cure; the sore being continually torn open, it sometimes becomes excessively irritable and painful, like those slight incisions about the joints of the fingers which often become intractable from a similar cause. In this condition the case is somctimes complicated with spasm of the sphincter, and the patient is said to labour under fissure of the anus. (See § 11.) Unfortunately the surgeon is hardly ever consulted on the first occurrence of an accident apparently so slight that it may escape the notice even of the patient, or it is probable that few cases would resist the ordinary measures for the treatment of slight lacerations in other parts, the proper regulation of diet, aperients, and the temporary repose produced by opiates when such remedies are admissible.

Abrasions, or other injuries of a mechanical nature, sometimes produce ulcerations of the middle region of the anus which extend over a considerable portion of its surface. The discharges do not find a perfectly ready egress, owing to the constriction of the external sphincter, but make a lodgment, and become irritating in the intervals between the stools. These ulcers are treated on general principles in other respects, but the circumstance just mentioned, together with the mechanical action of the muscle, and the difficulty of access to the sore, sometimes render it advisable to make a free lateral incision into the external sphincter to facilitate the cure. We are informed by Dr. Physick that he has frequently performed this operation for the cure of obstinate ulcers between the sphincters.

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b. *Aphthous ulcerations.* Besides the excoriations produced by irritating discharges in dysentery, cholera, and other visceral diseases, the chapping resembling that of the lips in winter, various cutaneous diseases, &c., all of which occasionally attack the anus, and give rise to more or less serious inconveniencc, we have

noticed a complaint in several cases that appears to have escaped observation, or to have been confounded with other more serious lesions. It is superficial excoriation or ulceration, similar to that so frequently noticed upon the inside of the lips, tongue, and other parts of the mouth, presenting an irregular and dark-red margin, the centre being covered with adherent coagulated lymph. When several exist at the same time, and approach each other, the intervening cuticle assumes a dead-white hue, and is somewhat thickened, as if by the imbibition of the moisture of the part. The pain is intense and burning, and is very much increased by contact with the dry finger, or by the discharge of fæces. In the cases that we have noticed, it has been contemporaneous with similar excoriations of the mouth, and decided symptoms of abdominal irritation. It is distinguished from most other superficial ulcerations by the absence of ichorous discharge; from chancre, by the want of the hard and elevated or excavated margin, and from the disorganizations of the lining membranes of the anus and rectum from secondary syphilis and other very serious diseases, by the absence of all cartilaginous hardness of the integuments, or disposition to tubercular enlargements. It seems to be generally, if not always, limited to such parts as are covered by cuticle, so that it does not appear to extend beyond the margin of the internal sphincter. In the first case of the kind which fell under our care, we employed, in addition to the necessary constitutional treatment, solutions of the sulphates of alumine, zinc, and copper, and the dilute acids, without any benefit; but the symptoms were very much relieved by an ointment of extract of cicuta, which we have since applied with equal effect in two other cases. Not having seen this complaint in its earliest stage, we cannot pronounce positively upon the mode of its commencement; but the similarity between these excoriations and those of the mouth already noticed, leaves little doubt of their identity. These latter commence with the secretion of a thin layer of lymph beneath the cuticle, which, if not speedily reabsorbed, produces exfoliation of the cuticle, and extremely painful ulcerations. This disease resembles aphtha very strongly, and is probably the same with the affection noticed under that title as occasionally occurring within the vulva, as well as in the mouth, by many writers, from Hippocrates to Van Sweiten, and also by some modern authors. (See *Dict. de Méd.* edit. 1. Art. *Aphte.*) We have seen the same disease upon the mammary areola, of females. In one of the cases, it produced very severe general disturbance; and as there exists perhaps but little distinction between this irregular deposit of lymph and the genuine aphthous pustule, which is known to be attended by irritations throughout the alimentary canal, it is not improbable that we may be in error in confining the sphere of its influence to parts invested with cuticle, particularly as symptoms of abdominal irritation are generally present. (See *Aphthæ.*)

c. *Venereal ulcerations.* These may be primary, or secondary, and may take various forms. The rhagades of this part are generally long narrow ulcers concealed in the converging folds of the skin, and are readily distinguished from other superficial affections, by the peculiar ichorous discharge, the copper-coloured hue of the surrounding parts, and the grayish surface of the sores themselves.

Chancres, when they occur in this situation, usually commence in the middle region between the sphincters, and frequently extend high into the rectum; where, when neglected, they sometimes give rise to fistulæ, peritonitis, perforations of the bladder, or other very serious disasters. They are easily recognized by their excavated or festooned edges, and the copper colour of the skin in their neighbourhood; the absence of excessive sensibility and of lancinating pain; and the freedom from scirrhosity in the surrounding surface; the hardness, when present, being confined to the edges alone. These marks are quite sufficient to distinguish them from carcinomatous disease, and from that form of scirrhus or tubercular stricture, sometimes attended with ulceration, which Delpech considers as a form of secondary syphilis. (See *Rectum.*) These ulcers are said to yield but seldom to general treatment alone; but the local measures required are such as are requisite in similar ulcers of other parts: they will be mentioned in the appropriate general article. According to M. Velpeau, deaths result in the French hospitals, from venereal ulcerations of the anus and rectum, much more frequently than is generally supposed; but they are certainly very rare on this side of the Atlantic.

For information on ulcerations and degenerations of the tegumentary membranes of the anus connected with scirrhus and cancer, see the article on the pathology of the rectum.

There is yet another familiar disease

frequently affecting the anus, and giving rise to superficial ulcerations—this is the syphilitic mucous pustule; but as this disease occurs on the perineum, the labia pudendi, the pubis, the mammæ, and occasionally on other parts of the body, we refer the reader, for information on its pathology and treatment, to the article *Syphilis.*

§ 11. *Fissure of the Anus.* This title has been bestowed by Boyer upon an assemblage of symptoms very rarely observed by American practitioners. We have never met with it, either in public or private practice, and several eminent surgeons in Philadelphia declare that it has not occurred under their observation. The English writers on the anus and rectum use the term indeed, but they sometimes apply it to other affections which have little in common with the disease described by Boyer. In France, however, it has attracted much attention; it is said to be by no means rare at Paris, and it is necessary that we should notice it in order to render this article as complete as possible.

This disease consists in an elongated ulceration of the middle and lower part of the anal canal, sometimes extending upward onto the mucous membrane above the internal sphincter, sometimes concealed between the converging folds of skin around the margin, and generally invisible until the anus is considerably everted. This peculiar ulceration is said to be invariably attended by spasmodic contraction of the sphincters and severe burning pain; at first felt only at stool and for some time afterwards, but gradually becoming more permanent;—which contraction and pain are considered as essential symptoms of the disease.

No change of structure is discoverable by the finger, introduced into the anus, unless in complicated cases; the ulcer being generally so narrow and shallow. The spasmodic contraction of the sphincters offers, however, powerful resistance to the introduction of the finger, and the patient suffers great pain under all attempts at dilatation. The situation of the fissure may be ascertained by pressing in various directions round the periphery of the canal; for the moment pressure is made upon the ulcerated line, the pain is increased to agony. If the fissure extends far downward, it may be perceived externally by simply separating the converging folds of the marginal skin. In most cases it can be seen by very careful inspection, while the anus is everted. Its appearance is that of a very narrow ulcer, marked by an increased redness, but without much induration, involving part or the whole of the thickness of the mucous membrane. The examination is extremely painful. Such is the description of fissure of the anus, as given by most of the writers by whom it is noticed. M. Merat asserts that the fissure sometimes extends beyond the mucous membrane and invades the muscular envelope of the canal. (*Dict. des Sciences Médicales.* XV. 544.) But M. Dupuytren avers that it very rarely penetrates the whole thickness of the integument. (*Leçons Orales.* III. 284.)

The *symptoms* at first are not exceedingly severe. According to Merat, the disease is ordinarily announced by more or less considerable pain, on every attempt at stool, which becomes excessive and of long continuance when the fæces are hard, and at first, generally subsides in an hour, or less time, after each evacuation. The patients are most comfortable in bed, and for that reason frequently avoid rising. The pain is, according to M. Merat, sometimes paroxysmal, which he attributes to the pressure of accumulated fæces pressing on the sphincter. At its greatest height this complaint is, says Velpeau, accompanied by horrible suffering. The patients compare the pain they feel at the moment of an evacuation, to that which would be produced by the passage of a red-hot bar. This sensation of burning is sometimes so severe as to produce inexpressible anguish, with threatenings of convulsions, or syncope. Others say it seems as if something was tearing the fundament. In the intervals between the stools, there sometimes remain only smarting or lancinating pains, more or less severe, a sensation of weight, and some griping. On the approach of defecation, on the contrary, the pains become obviously augmented. They do not acquire their greatest violence until the moment of the expulsion of fæces, and go on decreasing for some hours.

The constipation becomes so obstinate, that alvine evacuations take place but once in eight, ten, or twelve days, if they are not promoted by art. The patients, having an incredible dread of going to stool, postpone the moment as long as possible, although they are aware that they suffer more by the delay. The one, two, three or four injections necessary to procure a stool, sometimes prove still insufficient, and purgatives given by the mouth are absolutely required to open the bowels. Some patients think themselves under

the necessity of taking purgatives on alternate days. A woman treated by M. Boyer resorted to the use of a canula, which she fixed in the anus. A patient at l'Hôtel-Dieu insisted that he would prefer death to the necessity of going again to stool. Even the fluidity of the discharges does not prevent the sufferings in all the subjects, as has been proved by one of the cases related by M. Boyer. Although some persons are able to walk, sit, or occupy many hours in employment, during the intervals between their attacks, others are obliged to remain in bed, although they suffer cruelly with the heat and fatigue. In certain cases the lancinating pains shooting toward the bladder or the uterus, according to the sex, extend even to the greater part of the hypogastrium. Digestion is disturbed. From the fear of evacuations the patient eats but little, and he loses his natural colour. His features soon begin to express the sufferings he endures, so that one might believe that he laboured under some profound organic lesion. Spitting, coughing, or even singing; in short, all sudden or rather strong efforts of the lungs, sometimes exacerbate the pain. The attempt to introduce into the anus, a syringe, tents, canulæ, or any other foreign substance, produces the dread of alvine evacuations. The pain occupies but a small portion of the circumference of the canal, and is often accompanied by pulsations like those of phlegmon. (*Dict. de Méd.* III.)

The *diagnosis* of this complaint remains unsettled, writers having disagreed as to the precise application of the term *fissure of the anus.* Some have included under it not only the linear ulcerations of the canal attended with spasm of the sphincters, but also, the transverse or other ulcerations of the upper portion which have been mentioned in the previous section. (Mayo.) Others consider both the spasm of the sphincters and the linear ulceration, as essential to the disease, and regard them as standing in the relation of cause and effect; one party deeming the former to be the primary symptom, (Boyer, Merat, &c.), another, the latter, (Roche and Sanson, Blandin, &c.) A few go still further, and either speak of the spasmodic constriction as the true lesion, and the elongated ulcer as a secondary complication (Dupuytren); or, on the other hand, they class under the same general head, fissures accompanied by spasm, rhagades, and simple crevices or chapping of the cutaneous tissue around the anus. (Montegre.) "These three words," (*Crévasse, Rhagade, Fissure,*) "have the same signification," says the author last mentioned. "They all relate to a little longitudinal ulceration, of which, the varieties depend solely upon the cause which has produced them."

It seems to be almost universally conceded that a considerable number, according to Dupuytren one fourth, of the cases, are affected with spasm without ulceration; but it is deemed by most that the ulceration is never found unattended with spasm, unless the term fissure is applied in the most extensive acceptation, as given by Montegre. The latter position appears to us untenable: 1st, because a slight linear ulcer of the middle region of the anus may very readily exist undetected, if not complicated with spasm or other marked pain; and if detected by the patient, it may still be concealed from the surgeon, through motives of delicacy, or through carelessness with regard to an affection so trivial in its nature: 2d, because it is conceded that the spasmodic symptoms of fissure generally increase slowly, and do not become severe until the ulcer has been irritated very frequently and for a considerable length of time, and it is reasonable to suppose that spontaneous cures take place in many instances before the excessive irritation and consequent spasm have rendered such a termination impossible: 3d, because in various operations on the anus, linear ulcerations of the middle portion of the canal are frequently produced, and are readily healed without the occurrence of spasm: 4th, because in the ulcerations caused by operations, the cure has been protracted for a long period, and the irritability of the part has given rise to great pain and inconvenience in going to stool, yet no spasm has occurred. We have elsewhere alluded to an interesting case of this kind occurring at the mesial line on the front of the canal, in a patient of the late Dr. Wistar, in which the ulcer was cured by simply preventing the motions of the thighs upon each other, a plan adopted at the suggestion of Dr. Physick (§ 10.): 5th, because rhagades, or linear ulcerations of the same form occurring in the lower portion of the canal, in venereal cases, and which always attract attention, from their external location, are not unfrequently extended into the middle region, without producing spasms, as we are convinced by actual observation: lastly, because the attempt to explain the foregoing facts and to avoid the obvious conclusion, by asserting that there is any-

thing peculiar or *sui generis* in that species of ulceration which is found so frequently associated with spasm by continental surgeons in Europe, is a *petitio principii*, and we have been unable to discover any facts in its support among the authorities within our reach.

Having described the various causes and varieties of spasm of the sphincters, in the appropriate section of this article, it is unnecessary to adduce further proof that this affection may originate from other irritations than those seated in the middle region of the anal canal. We cannot therefore avoid the conclusion that if the term Fissure of the anus be retained as a nosological distinction, it should be confined strictly to cases of spasm of one or both the sphincters, complicated with a linear, irritable ulcer of the middle region, which may be extended into the upper region, or may even originate there in cases affected with internal hemorrhoids, according to M. Dupuytren. We are equally compelled to consider the order of the symptoms to be accidental. As it is very evident that the causes of the ulceration are generally mechanical, and that it may occur from the friction of the fæces, when there is pre-existent spasm; or from simple distension, when there is not—and as it is equally certain that the spasm may arise directly, from the irritation of the crevice, or more remotely, from disease of other parts, peculiarities of temperament, or even congenital hypertrophy of the muscles, it follows that either may induce the other, or the two accidents may be associated without being mutually dependent.

These remarks being premised, it is evident that the diagnosis can seldom be rendered certain by the rational signs alone, unless where the disease has existed for a considerable time and remains free from complication with other inflammatory affections of the canal. Under such circumstances the existence of fissure may be determined with tolerable certainty by the symptoms already enumerated, and more especially by the pain experienced at every discharge of fæces and at all efforts causing a descent of the anus, by its being more severe at the moment of greatest distension of this organ; and by the fæces being generally marked by lines of purulent or sanio-purulent matter from the fissure. When these signs fail, if the crevice is low, it may be frequently brought into view; when this is not the case, it may still be possible to ascertain its existence by the introduction of the finger, notwithstanding the pain caused by the attempt. It is remarked that the crevice is very rarely found to correspond with the mesial line of the body, and M. Labat asserts that the number of cases in which several fissures occur simultaneously is exceedingly small. When the spasmodic stricture is so complete as to prevent the exploration of the canal, as has been the case in some instances, the existence of the crevice cannot be completely proved, and the case must be considered and treated simply as Spasm of the anus (q. v.).

The *prognosis* of confirmed fissure, when abandoned to the unaided powers of nature, is always unfavourable. It may continue for years without producing death, when the alvine evacuations are rendered habitually soft by the administration of purgatives. A case of a lady is quoted by M. Vivent from the practice of M. Dupuytren, in which the use of calomel rendered the condition of the patient supportable for many years, but she did not recover. M. Velpeau declares that after an indefinite duration, the disease destroys the patient or terminates by producing some incurable organic affection. (*Loc. Cit.*) Fortunately the cure may be accomplished in nearly all cases by proper medical or surgical measures.

Of the *treatment* as well as the diagnosis of Fissure, so little was known before the time of Boyer, that we deem it unnecessary to carry back the history of the disease anterior to that period. Those who are curious to know the rude measures sometimes employed by Albucasis, and the few facts collected by the earlier members of the French Royal Academy of Surgery, will find a guide to their researches in the Bibliography to the present section.

It seems to be almost universally conceded that in cases of fissure, according to the restricted definition of the term which we have adopted, the application of emollient or narcotic topical remedies is very rarely attended with permanent benefit, and scarcely ever produces a cure. Repeated laxative or emollient injections, fumigations with warm water, fomentations with various vegetable decoctions, general bathing, the hip-bath, opiate suppositories, and unguents, have all been employed in a great number of cases, and have sometimes rendered the pain more supportable; but the cases in which cures are said to have been effected by such means are very few in number and mild in character. In the very extensive practice

of BOYER, there occurred a single instance of success by such measures; and we are informed by Dr. SAMUEL JACKSON that he has recently cured a patient by the continued application of an ointment of tobacco. The details of the former case are not given, and the latter has not yet been communicated to the public.

One of the favourite prescriptions of BOYER, from which he obtained temporary good effects, was an ointment composed of equal parts of lard, the juice of the houseleek, the juice of the garden nightshade, and the oil of sweet almonds. Of this mixture, moderately warmed, he injected into the rectum two or three spoonsful, by a small syringe, and repeated the operation several times in the day. DUPUYTREN indeed still continues to place confidence in the local application of narcotics, and has extensively employed the belladonna and datura stramonium. His favourite recipe is as follows: ℞ Axungiæ, ℥vi.; Extr. Belladonnæ, Plombi Acetatis, āā ℥i. M.

As has been already stated, this eminent surgeon considers the spasm of the sphincters as the primary, and the ulcers as a secondary symptom; and he appears to employ the remedy just mentioned to produce a relaxation of the fibres, rather than to effect any change in the ulcer. The ointment is spread upon a plug, or tent of moderate size, which is introduced several times during the day; and the size of the tent is gradually increased to that of the index finger. "The continual use of this ointment during some days often effects the complete removal of the pain, and spares the patient a resort to an extreme and very painful measure." (*Leçons Orales.* III. 287.)

The number of cases of success obtained by this treatment, would seem at first to be very encouraging, but it must be borne in mind that M. DUPUYTREN includes under the head of Fissure, not only the crevices of the middle region of the anus, but those of the upper and lower regions also. Now in the two last forms of disease it is obvious that measures may prove successful, which would be of no avail in the first: indeed, they do not come within the range of our definition of Fissure, being ulcerations of constant occurrence, and seldom producing spasm; hence they occur and may continue independently of the hyperaction of the sphincters, and even when complicated with that affection the introduction of a bougie or any other substance does not act upon them in the same manner as in cases of proper fissure. (See § 2 and § 10.) It so happens that in the only observation reported in proof of the efficacy of this mode of treatment, (chosen, as the reporters state, *au hasard*, from a great number,) the fissure was *very superficial.* The patient was completely cured in fifteen days. (Ib. 287.) Indeed, it appears that M. DUPUYTREN himself prefers the incision of the part, when the crevice is seated "at the level of the sphincter muscle." (Ib. 291.) M. VELPEAU has made a few comparative experiments upon the effects produced in this disease by various unguents, among which he included simple cerate, and the preparations of BOYER and DUPUYTREN, mercurial ointment, &c., and he has been unable to detect any difference in their action. It may therefore be stated that the chief weight of surgical experience proves that all the topical measures above mentioned are merely palliative in fissure properly so called.

The attempt has been made to effect a cure by changing the surface of the crevice, by means of actual or potential cautery. The former agent is reported to have been employed successfully by GUÉRIN, but, as BOYER very justly remarks, it could only be employed in those rare cases in which the crevice is unaccompanied by constriction, unless its action was extended to the sphincters, which it could not be *without inconvenience.* (*Mal. Chir.* X. 135. Note.) M. BECLARD claims almost constant success by the use of the nitrate of silver, and the Reviewer of DUPUYTREN's Clinical Lectures in the *Med.-Chirurg. Rev.* for Oct. 1834 (p. 327.), states that he has found a single touch of this substance to do more to allay the spasmodic contraction of the sphincter than any species of sedative or narcotic. The objection just stated is applicable with nearly equal force to this mode of treatment. M. RICHERAND and M. VELPEAU both oppose it strongly. The former states that he never obtained any advantage with it at l'Hôpital Saint-Louis, and the latter is inclined to attribute the success of M. BECLARD to the dilatation which he practised at the same time with the cautery. M. LABAT declares that in about twenty cases in which he has employed the nitrate of silver, the symptoms have been invariably aggravated.

The treatment of fissure by dilatation was so strongly condemned by BOYER (see § 2.), that he concludes his remarks upon this subject with these words: "In no case have I observed good effects from this measure—it has always been useless

or hurtful." (*Op. Cit.* 135.) Until recently, the opinions of the most eminent surgeons have responded to this statement, but the plan has at present some warm defenders. Beclard, Marjolin, Nacquart, and Gendrin, have repeatedly succeeded by it, and M. Dubois, according to M. Velpeau, maintained that it was always successful in his hands.

The dilatation is effected by the introduction of tents or plugs of lint, gradually augmented in size until the resistance of the sphincter is completely overcome. M. Velpeau states that he has as yet employed them only twice, but their effects have been so happy that he does not hesitate to recommend them formally. The painful and constricted condition of the organ he thinks a much less important objection than it appears to be. It is only necessary to persist in the treatment without shrinking and to enlarge the tents rapidly to the greatest possible volume, whatever may be the resistance of the sphincter. The pain, excessively severe during the first hours, becomes gradually calmed and almost disappears by the time the fifth or sixth tent is introduced. He believes that practitioners who have sufficient resolution to force their patients to submit to the pain at first, will obtain signal success by this mode of treatment. (*Dict. de Méd.* edit. 2. III. 300.) If the plan advocated by M. Velpeau is indeed deserving of so much praise, we cannot avoid the impression that less painful and more rapid modes of dilatation might be devised.

The attempt to cure fissure by incision has been practised by many surgeons. The first trace of this kind of operation is found in the writings of Albucasis, who recommends excoriating the ulcerations with the nail, or scarifying them with a cutting instrument. Dionis also scarified them; but these observations have little value, because of the imperfection of the diagnosis. But the method that has proved successful in the greatest number of instances is the complete division of the sphincters, as practised by M. Boyer; the constriction being thus relieved, the crevice generally heals without difficulty. "The manner in which I practise this operation," says this distinguished surgeon, "is as follows: The patient has taken, three days before, a gentle purgative, and on the day itself, a laxative injection, to empty the intestinal canal, and in order that the desire to go to stool should not be felt for many days. I place him upon his side; as for the operation for fistula in ano: I introduce the left index finger, covered with cerate, into the rectum; I pass a very narrow bistoury, cut square, and rounded at its extremity, and laid flat, along the finger. The cutting edge of this bistoury is then directed toward the right or left side, according to the location of the crevice; and I divide at a single cut, the intestinal membranes, the sphincters, the cellular tissue, and the integuments. I thus form a triangular wound, of which the summit corresponds to the intestine, and the base, to the skin. It is sometimes necessary to elongate this incision, and I make a second cut with the bistoury. In certain cases, the intestine retires before the instrument, and the wound of the cellular tissue extends higher than that of the intestine; it is then necessary to introduce the instrument, *de novo*, into the rectum, to elongate the incision of the intestine. When the constriction is extreme, I make two similar incisions, one on the right, the other on the left; and when the crevice is situated in front, or behind, I do not comprehend it in the incision." (*Op. Cit.* X. 137.) The part is then plugged with lint to prevent immediate union; long compresses are applied, and the whole dressing supported by a proper bandage. Hemorrhage rarely supervenes, and slight compression checks the bleeding. The first dressing is not removed for three days, after which a dressing of simple cerate on lint is sufficient. It should be frequently changed during the first few days, and the wound well cleansed at each removal. The cure generally requires a month or six weeks, sometimes more, and it was complete in every case in which it was performed by Boyer.

Other surgeons have not been so uniformly successful, for cases of failure are mentioned by Beclard, Richerand, Roux, and Lagneau. Velpeau speaks of two cases of death from this operation, one after many months, from inflammation and adhesions of the pelvic viscera, with infiltrations of pus in the cellular tissue; the other in a shorter time, with entero-peritonitis. When we consider the number of patients operated on, these instances do not appear at all remarkable.

The mode of operating has undergone but little alteration in the hands of other surgeons, but it is now generally held important to interest the crevice in the incision whenever it can be safely done; and when there are many fissures, divisions more numerous than Boyer thought necessary, are recommended. M. Labat has indeed invented a peculiar instrument

for this purpose, founded upon the cystotome of Frere Côme, but we do not perceive that it possesses any great advantages over the simple, blunt-pointed bistoury.

It may yet be considered questionable whether there exists a necessity for the complete division of the sphincters in cases of fissure. This very severe operation is founded on a hypothesis, and there are instances of cure where much slighter incisions have been made. One of the most interesting of these is the third observation of Dupuytren. (*Op. Cit.* III. 292.) The symptoms were very severe and complicated, and the crevices were numerous. They were all incised, but the knife was only carried to the depth of three or four lines, yet the patient recovered promptly and completely.

We might here enlarge upon the general disorder of the system produced by the severer forms of fissure, which sometimes masks the original complaint and deceives the inexperienced, and also upon the various complications of the disease; but the former is common to all severe irritations about the anus, and the consideration of the latter would lead to a mere repetition of the contents of other sections of this article.

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§ 12. *Preternatural Pouches or Cavities of the Anus.* This is a peculiar form of diseases of the anus, rare indeed, but much less so than some that have been already described, although it appears to have escaped the notice of surgical writers. Though agreeing in location and perhaps arising from similar causes with some forms of occult fistula and abscess of this region, it differs from them essentially in its progress, symptoms, and requisite treatment. It was first made known to the profession by Dr. Physick, under whose care a case occurred very soon after his first settlement as a practitioner in Philadelphia in 1792—and it was regularly described by him in his annual course of surgical lectures. Most of the patients who have been brought to Dr. Physick for advice in consultation by other practitioners, have been thought to labour under an imaginary complaint or under neuralgia of the anus; and there is reason to suspect that some of the cases described as neuralgic, by various authors, have been really instances of the disease of which we are now speaking. (See § 1.)

The *symptoms* which mark the presence of these preternatural cavities are as follows: The patient sometimes makes little or perhaps no complaint during the intervals between the stools, but more frequently he suffers a continued uneasiness about the anus which varies in character

in different individuals. Some state that the sensation is indescribable, but very uncomfortable; others compare it to the crawling of an insect within the canal; while others suffer an intolerable itching, sometimes sufficiently severe to produce insomnolence and extreme distress. It is apt to be most severe at night. One patient described the uneasiness to feel like the pressure of a ton weight upon the anus. Pain is rarely felt except after a stool, *nor is it then present at every evacuation;* several days may pass over and several discharges may take place without material exacerbation of the symptoms, yet at the next stool the pain may be excruciating. The exacerbation does not precede the evacuation as it generally does in inflammatory affections of the anus, but commonly follows after an interval of a few minutes; it is most severe at its first attack, and gradually subsides and disappears in a few hours. Dr. PHYSICK has never observed it to be complicated with spasm of the sphincters, as is the fissure of the anus. (See § 11.) When the finger is introduced into the anus, it perceives no well-defined tumour, and seldom any other marks of disease. There is probably in all cases more or less discharge from the parts, but this is not always obvious; occasionally the margin of the orifice is bathed with serum or an increased secretion of mucus, but in other patients nothing of the kind is observed, and if the discharge takes place it must remain confined within the external sphincter until mingled with the fæces in a common evacuation. Pus is never observed while the disease retains its simple character, but when it becomes complicated with inflammations in or about the part affected, suppuration does occasionally supervene. Such are the rational signs of the disease, and they are sufficient to furnish a tolerable diagnosis. But in this, as in all other complaints of the anus, we must depend mainly upon actual examination to determine its character positively.

Dr. PHYSICK is in the habit of exploring the canal by means of a probe with about half an inch of its extremity doubled back upon itself so as to form a kind of hook, as was recommended by HEISTER, DIONIS, &c., in searching for occult fistulæ. If the uneasiness and other symptoms are really occasioned by the presence of these cavities, a little patience and perseverance in causing the probe to advance and retreat along the canal, so as to bring the point to bear successively on various parts of its circumference, will render their existence and character sufficiently obvious. The reverted point passes through a small orifice, and enters a cavity or hollow space of greater or less dimensions, situated immediately beneath or within the integument; and it sometimes descends so low as to become prominent under the external skin around the margin of the anus. The pouch is so exquisitely sensitive, that the presence of the instrument gives rise to acute suffering; and so much of its parietes as is formed by the lining membrane of the canal is diaphanous, permitting the silver to shine distinctly through. Even when the cavity is extended beneath the external integuments, the point of the probe is sometimes visible in the same manner. In some cases, several of these pouches exist at the same time. The peculiar site of their orifice is what we have called the middle region of the anal canal, or between the sphincters, and their cavity does not appear to extend above the margin of the internal sphincter. From their position, these pouches are continually liable to receive small portions of fæces during the evacuation of the rectum, or the subsequent contraction of the sphincters; and to this cause may be attributed the violent pain experienced after some stools, and its absence on other similar occasions. The character of the pain as to duration appears to be plausibly explained by the same accident. When the particle of fæces is at first received into the cavity, it produces of necessity considerable irritation either by its mechanical or chemical properties, but as it becomes softened or diluted by the secretions of the part it is rendered gradually less stimulating, and at last it may be partially or wholly removed by the discharge; hence the gradual subsidence of the pain and its frequent cessation after a few hours. The fact of the reception of such foreign matters into the cavity is placed beyond doubt, for Dr. PHYSICK has actually discovered and removed minute portions of fæces, and, in one instance, a small seed so situated, at the moment of operation.

We will also venture to suggest *a probable explanation* of the fact that the accession of pain does not generally take place in the act of defecation, but rather a few minutes after the discharge has been completed. A cavity located as these are, and having but a small orifice and very flexible parietes on the side next the canal, must be necessarily compressed during the passage of fæces; its cavity must be nearly or quite obliterated, and its contents chiefly or entirely expelled; it is therefore not

very likely to arrest any part of the mass *in transitu*, particularly as there is no partial septum, but rather an enlargement of the canal at the spot where the orifice is located. But it is well known that the middle region of the anus is rarely perfectly evacuated when the fæces are at all firm in consistence; some portions are extremely apt to remain in the slight enlargement existing between the sphincters. Now it appears to us that after the contraction of the sphincters, the sides of the cavity being in a great degree relieved from pressure, and its orifice flaccid, the liability to the admission of minute portions of fæces must be much increased. This remark may be regarded by some as speculative and as not very important, but the peculiar time of the access of pain is important in the diagnosis, and nothing should be neglected that tends in any degree to disentangle the confusion in which the diseases of the anus and rectum have been involved.

On the *cause* of the preternatural cavities of the anus, Dr. Physick entertains some views which can hardly be regarded as speculative. In his opinion, they probably commence in the same manner with one of the forms of hemorrhoidal tumour. The constriction of the sphincters, which embarrasses the venous circulation of the part, aided by the pressure exerted in passing difficult stools, frequently give rise to ecchymoses beneath the integuments. The effused blood produces no irritation of the cellular tissue in which it is placed, but forms for itself a simple inert receptacle. If the blood is neither absorbed nor discharged, but remains or becomes enlarged by successive ecchymoses, it constitutes (certain authorities to the contrary, notwithstanding,) one form of hemorrhoid. If, on the other hand, some accident, or the absorption of the integument, gives exit to the blood after the cavity has become accustomed to its presence, the cellular tissue shows little disposition to reunite, no obvious marks of inflammation appear, and a preternatural cavity is established.

In support of this explanation, which is urged with characteristic caution, as an hypothesis, Dr. Physick states that in the early part of his practice, he has in several instances operated on hemorrhoidal tumours of the same part, in which, after the removal of the coagula, the part presented precisely the same aspect with the preternatural cavities, wanting only the orifice; he refers also to the existence of similar cavities after the discharge of ecchymoses of the scalp, such as most surgeons must have seen, particularly in children, and which often prove tedious and difficult of cure; he has also witnessed the same accident in other parts of the body. In most cases the first appearance of the cavities was preceded by troublesome piles.

The *diagnosis* of this affection is not very obscure. It is distinguished from ruptures and ulcerations of the superior portion of the canal, and from superficial inflammations, by the absence of all considerable discharges either of pus or mucus, and by the freedom from that gradually increasing pain which occurs, in such complaints, from the pressure of the fæces accumulating above the sphincters. It is alike distinguished from the cases just mentioned, and from fissure of the anus, by the occasional absence of all pain at stool, and also by the moment of the greatest suffering being, in this disease, some time after the evacuation, whereas, in the others, it is at the moment of the passage. From neuralgia of the anus, with which it has been frequently confused, it is widely removed by the regularity with which the function of defecation is performed; the absence of all marks of irritation in the urinary apparatus; the strict relation between the stools and the access of pain; and, in many cases, the excessive pruritus complained of in the intervals. It is very remarkable also, that the preternatural cavities have never yet been seen complicated with spasm of the sphincters. There remains but one disease for which it might be mistaken; this is the occult fistula, and it is particularly important to point out the essential differences between these complaints, because of the opposite plans of treatment which they require—notwithstanding their common location, and the similarity, in many respects, of the causes which produce these cavities and also some forms of the fistula. Occult fistula is always preceded by inflammation, and generally by abscess, with its well-marked train of symptoms. (See § 13.) Even when it succeeds the rupture of a hemorrhoidal tumour, it is preceded, or immediately followed by suppuration (Ribes, in *Mém. de la Soc. d'Emulat.*); and this is likewise the case when it originates in a perforation of the intestine by ulceration or mechanical injury. The cavity formed by the fistula is more deeply seated, and modern experience proves that it is altogether unnecessary to remove considerable portions of the walls of the abscess, as was done by ancient surgeons;

for a simple incision, laying the whole cavity open to the canal, is found sufficient to effect a cure. (See § 14.) When portions of the integument were removed in fistulæ, it was found that the loss of substance occasioned contractions of the cicatrix which sometimes interfered materially with the due exercise of the proper functions of the part. The preternatural cavities of the anus, on the contrary, are not preceded by marks of inflammation. Even if caused by the evacuation of a hemorrhoidal tumour, no suppuration follows, but the cavity remains sluggish and indisposed to contract adhesions by which it might be obliterated. It is always superficial or situated immediately beneath the integuments. Moreover, it is necessary to remove the greater part of the internal covering of the cavity, together with the orifice, in order to insure a cure; for if any portion is allowed to remain beneath the orifice, the same sluggishness of tissue may continue in this remaining part, and after the wound produced by the operation has healed, a cavity of smaller dimensions may still subsist, and give rise to a return of symptoms. After the excision of the inner parietes, no disposition to retraction in consequence of the loss of substance is evidenced by the cicatrix, or at least, no such disposition has been yet observed in any case not complicated with other diseases; a circumstance that proves the wide difference between the condition of this cavity and that of a suppurating or granulating surface.

The *mode of operating*, devised by Dr. Physick for the relief of this complaint, (one which has proved successful in every instance,) consists in drawing down the membranous covering of the cavity by means of a bent probe, and then removing the whole of this portion, or as much of it as possible, by the scissors, taking care to include the orifice by which the probe enters, in the part excised. The opposite surface is thus laid completely open to the anal canal. It must be borne in mind that several of these cavities may exist at the same time, and that after the patient is relieved by the cure of these, others may be formed consecutively, in some instances. In one case particularly, numerous operations were successively performed during a period of several months, for the extirpation of a series of these sacs, which were developed, one after another, on the same side of the canal, in the same individual. The surgeon should therefore repeat the operation as often as necessary, until the complaint is effectually eradicated; and it is evident that due attention to the habitual condition of the bowels, so strongly insisted on in the preceding sections, is equally imperative here, if we would completely remove the causes of the disease.

We cannot quit the present subject without expressing the pleasure we enjoy on this, as on all other occasions, in securing to the rightful claimant the credit of services rendered to humanity; yet it is mournful to reflect that the vast funds of knowledge and experience accumulated by one who has filled, so long and so honourably, the first station among American surgeons, should remain accessible to but a small portion of the medical public. They lie chiefly buried in his own mind, or in the memory of those who have enjoyed the happiness of attending his deeply impressive discourses. Abroad, a great surgeon whose avocations prevent him from publishing the results of his experience, has always his reporters. The novel opinions of Sir A. Cooper, of Dupuytren, &c., reach us, almost as soon as uttered, through the medium of the press; but on this side of the Atlantic, we have been shamefully negligent of our own claims to distinction. That no one who has enjoyed the privilege of hearing the clinical remarks and the public lectures of Dr. Physick, has stepped forward to do justice to the Professor and the Profession, is not only a matter of surprise, but a just cause of national regret. How small a portion will be ultimately rendered to Cæsar, of all that bears his image and superscription!

§ 13. *Abscess of the Anus.* The neighbourhood of the anus, like all other parts in which free cellular tissue abounds, is subject to the several varieties of abscess, and it is remarkable that inflammations of this region almost invariably result in suppuration, unless they are confined to the integuments. Boyer observes that even in those rare cases which apparently terminate by resolution, it is possible to detect a nucleus or induration, more or less deeply seated, which remains, and ultimately gives rise to a consecutive abscess. (*Mal. Chir.* X. 101.)

The varieties observable in the symptoms and progress of these affections are chiefly owing to the peculiarities in the anatomical structure of the parts where they are located. Thus, those which occur at a considerable distance from the anal orifice, near the nates, and between the skin and superficial fascia, are seated in a dense, adipose, and fibrous cellular tissue. The superficial fascia generally prevent

them from extending deeply, toward the pelvis, and the character of the tissue opposes the formation of sinuses; they therefore present, in most instances, that circumscribed, *anthracoid* appearance to which we alluded in the section on *Inflammation.* Those which are situated nearer to the orifice, or within its verge, but exterior to the superficial fascia, are commonly circumscribed, at first, in the same manner. They are generally small, and are called *tubercular abscesses*, from the form of the little tumour immediately beneath the integument, in which the suppuration takes place. Those that are wholly or in part internal, are termed also *hemorrhoidal abscesses.* The close adhesion of the skin along the mesial line, renders it difficult for the pus to travel from one side to the other, but there is much less resistance to its progress in the direction of the anus, and the formation of a sinus or external blind fistula is often the consequence of tuberculous abscess, even when seated at a considerable distance from the anus, on the perineum (see § 14.); and when it is located within the verge, the continual engagement of fæcal matter, or the secretions of the part in the orifice of the abscess, may occasion true fistula.

When the inflammation attacks more deeply seated parts, it is usually accompanied by all the well-known marks of *phlegmonous abscess;* the local and constitutional symptoms being severe in proportion to the importance of the function and the extensive sympathies of the anus.

The most common seat of the *phlegmonous abscess* is the recto-ischial excavation. The texture of the cellular tissue here permits of a free extension of the cavity in several directions, and it rarely fails to involve all the space between the rectum within; the ischium and obturator fascia, without; the aponeurosis of the levator ani, above; and the superficial fascia and integuments below. This great sac seldom approaches the surface, until it has denuded and thinned the parietes of the intestine to a considerable extent; but it may not evacuate its contents into the rectum, when competent surgical aid is invoked in time, even in cases which originate primarily from some lesion of that organ. If neglected, still greater extension may be given to the cavity, which then reaches the os coccygis, and as the aponeuroses are by no means insuperable bars to the progress of an abscess, the pus may not only extend upward along this bone and the sacrum, but may even reach the meso-rectum, and pass beyond any assignable limits. Though the raphe in front of the anus offers considerable opposition to the enlargement of the cavity, it does not in all instances arrest it, and in the neighbourhood of the os coccygis this barrier scarcely exists; nevertheless, phlegmonous abscess in the recto-ischial excavation is usually confined to one side, and if both sides become affected, they are generally attacked at different periods. In some cases, however, a single abscess has been known to denude nearly or quite the whole circumference of the intestine.

When disease of this character occurs in the thickness of the levator ani muscle, the pus is confined between the pelvic fascia above, and the aponeurosis of the muscle below, so that it naturally tends toward the rectum, in preference to taking any other direction, and generally opens into the intestine before it produces any very decided tumour externally. Its presence is often more readily determined by the introduction of the finger into the anus, than by an external examination.

When there exists either a primary or secondary communication between the cavity and the canal of the intestine, giving entrance to portions of fecal matter, the case is denominated a *stercoraceous abscess;* but as the existence of such a communication has an important bearing on the treatment, it is proper to state that the decided fecal odour and brownish colour so frequently observed in the discharge from abscesses about the anus, when first laid open, are not sufficient proofs that the integrity of the intestine is lost; for these appearances are common in all collections of fluids remaining long confined in the neighbourhood of the rectum, owing to the transpiration which is now well known to take place through all animal membranes. (See *Abdomen, abscesses of.* Vol. I. p. 78, &c.) M. Velpeau lays particular stress on this fact. (*Dict. de Méd.* III. 311.)

Phlegmonous abscess of the anus is always very rapid in its progress, and produces, in addition to the well-known local and general symptoms of the same affection in other parts, the following consequences which are peculiar. The anal canal is diminished by the swelling occasioned by the sac, which not only opposes a mechanical impediment to the passage of the fæces, but, in consequence of the extreme sensibility of the inflamed parts, renders the performance of the function of defecation excessively painful. A dread of evacuations, and generally, decided costiveness, are attendant on the disease. The irritation is also extended to the

bladder and urethra, and the discharge of urine is frequently rendered difficult—sometimes impossible. When the tumour is seated in the recto-ischial excavation, the fever and other constitutional symptoms are at once explained on a careful examination; but when it occupies a station above the aponeurosis of the levator ani, these symptoms are often more perplexing, because the swelling and hardness of the inflamed part are concealed by its depth. In such cases, if the finger be introduced into the anus, a rounded tumour is detected at a greater or less distance from the orifice, encroaching upon the canal; it is often as large as a nutmeg, or larger; well defined; hard, or exhibiting signs of fluctuation, according to the stage of the complaint; and almost always confined to one side of the intestine.

Gangrenous abscesses of the anus are usually still more extensive than those just described. They appear to be various in their mode of attack and in the rapidity of their progress, nor is the history of their several forms sufficiently complete to explain the nature of all these varieties. Both the anthracoid tumours seated near the nates, and the diffused cellular inflammation of the anus, which are sometimes classed with gangrenous abscess, have been already noticed, when speaking of Erysipelas, in § 6. of this article. Of the remaining cases, some are very rapid in their progress, and are attended with the usual symptoms of deep-seated phlegmonous inflammation; others are slow in forming, excite but little fever, almost no pain, and are usually attended by marks of considerable constitutional depression. The hardness is always very deeply seated and obscure at first, and neither softness nor fluctuation are perceptible until the disease is very far advanced; when the tumour generally involves a large portion of the nates. The integuments then feel doughy or pasty on pressure, from the presence of œdema; they assume a livid hue, and one or more escars soon make their appearance, into which a stylet will penetrate almost without resistance. (Boyer. *Mal. Chir.* X. 100. Sabatier. *Méd. Opérat.* II. 162.) It is hardly necessary to state the extent to which the loss of substance may be carried in cases of this character, especially if the abscess be not opened at an early period; but it is remarkable that the abscess is almost always confined to one side, and very rarely involves the whole circumference of the anus.

Besides these forms of the disease, the anus is sometimes the seat of abscess by congestion (q. v.), and abscess symptomatic of phthisis. Occasionally, collections of pus in other parts, such as the lumbar region (see *Psoas abscess*), make their way into the pelvis beneath the peritoneum or along the meso-rectum, and finally reach the surface, at the anus. Critical abscesses, which are not very unusually met with in this part, are generally of the phlegmonous character.

Of the *diagnosis* little need be said; the symptoms already laid down are sufficient in most cases. It is thought possible to confuse the gangrenous abscess of the anus, with that which arises from infiltrations of urine into the cellular tissue—but without considering the disorders of the urinary apparatus which precede the formation of the tumour in the latter complaint, and which are sufficient in themselves to determine its nature from the commencement, there is a peculiar blanched appearance and a urinous smell of the flakes of dead cellular tissue discharged on opening an abscess of this character, which is at once distinguished from the true stercoraceous or common gangrenous odour of the former variety.

On the *causes* of abscess of the anus much has been written, and several of the highest authorities have selected each his favourite cause, to which he has attributed nearly all the cases, to the neglect of other important sources of mischief; and this habit has sometimes led to narrow and exclusive practical views. There is really no mystery in the case. The disease may spring from any of the causes which produce similar affections in other parts, and also from a variety of accidents obviously dependent on the peculiar structure of the anus and the lower part of the rectum. Avoiding all discussion, we shall enumerate very rapidly the more important causes, with the names of some of the writers who have particularly noticed them, and shall complete the details of the references in the bibliography, to prevent confusion in the text.

The causes of tubercular abscesses are either internal or external. Of the former class are, 1. ulcerations or crevices formed by internal hemorrhoids which embarrass defecation (Sabatier), and which are said, by some, (we think, erroneously,) to give rise to actual infiltration of stercoraceous matter or of the vitiated secretions of the part, into the cellular tissue (Boyer); 2. the attrition of fæces, or foreign bodies, in their passage (Velpeau); 3. the irritations and ulcerations occasioned

by the lodgment of fæces and vitiated secretions in what we have denominated the middle region of the anus (LARREY); 4. the ulceration of a hemorrhoidal vein (RIBES). Abscesses produced by these causes, when allowed to open spontaneously, generally pour out their contents into the canal; giving rise to blind internal fistula, improperly so called, and do not acquire an external orifice until some time has elapsed.

The external causes are those which occasionally produce pustular tumours in other places; such as mechanical or chemical irritations of the skin; the bites of leeches (DANYAU); stimulating discharges, &c. Abscesses produced by such means often give rise to external blind fistula. If a communication with the rectum is ever formed, it is not till after a considerable period, and is more apt to take place at some distance above the anus, than in the former variety.

The more extensive abscesses of the anus, whether phlegmonous or gangrenous, rapid or slow in their progress, generally arise from similar causes. The phlegmonous and the rapid cases are met with most frequently in persons of hale appearance and a certain degree of embonpoint. (BOYER.) The rapid and gangrenous cases are probably caused by the actual escape of stercoraceous matter through considerable rents in the rectum, and they almost always commence at a great depth. Those which are longer in reaching the surface are generally of vast extent, and are connected with peculiar constitutional conditions, which have not been sufficiently investigated.

All these forms of the disease may originate from external violence, such as severe contusions (MARCHAND); but a vast majority of cases result from internal causes either in the rectum, or in other and sometimes distant parts. Of the former class are, punctures or lacerations of the intestine by sharp-pointed foreign bodies, such as pins, needles, fish-bones, &c., or the irritations produced by the lodgment of similar substances or hardened fæces in the follicles above the internal sphincter. (SABATIER.) Instances of abscess originating in or above the levator ani, are sometimes, though very rarely, found to contain pieces of bone or other hard bodies which have escaped from the alimentary canal (VELPEAU); and the records of surgery are rich in cases of abscess from the presence of foreign bodies. A vast variety of substances of all sizes, from a table-fork introduced per anum, to a small seed which has traversed the bowels, have been occasionally discharged from abscess of the anus. (See *Bibliography* of this section, and Art. *Rectum.*) Among the mechanical causes of this class may be mentioned some gun-shot wounds, and injuries inflicted by the syringe.

The venereal ulcerations, and those resulting from dysentery, &c., may also occasion these abscesses; and M. VELPEAU is inclined to attribute those forms of the complaint which appear after severe fevers, and in patients labouring under phthisis, to ulcerations of the rectum similar to those observed in other parts of the alimentary canal. But by far the most frequent of this class of causes, is said to be the irritation of internal hemorrhoids.

The internal causes of large abscesses of the anus are scarcely less numerous. Among them are the following: caries or other disease of the os coccygis or sacrum (HAWKINS), of the ischium (VELPEAU), of the dorsal vertebræ (Ib., RIBES), and a variety of supposed metastases.

Treatment. The detail of the various precautions rendered necessary in the treatment of a disease so various in its extent and in its causes, would lead us to encroach extensively upon matters which are more properly discussed under other heads. We shall therefore confine ourselves as much as possible to those points which have a peculiar relation to abscesses of this region only.

It has been remarked that resolution is almost impossible in cases of this kind, but it is of the highest importance to prevent the undue extension of the purulent cavity, because the extensive loss of substance which always results from these abscesses is the chief cause of the difficulty and danger which they occasion. A moderate antiphlogistic treatment should be instituted, to check the extension of the tumour; and the usual measures should be employed to hasten the formation of pus. No principle is better established than that abscesses of the anus should be opened at least as early as the first appearance of fluctuation, however obscure it may be; and there are not wanting, authorities both ancient and modern, who advocate this step at an earlier period. (PLATNER, VELPEAU.)

With regard to the manner of operating, there is much greater difference of opinion. The use of caustic, once in vogue, is now totally abandoned, and the bistoury is universally employed. With regard to the form, number, and direction of the incisions, very various directions have been

given, but it is unnecessary to notice them particularly, as the best surgeons agree in stating that the danger of hemorrhage is not to be dreaded. There is perhaps some convenience in making the principal incision in a line parallel to the anus, but it is of infinitely more importance that the opening should be so formed as to give the most ready egress to the pus, and that its dimensions should be ample, except perhaps in abscesses from congestion, and in those vast collections of pus which sometimes make their way to the anus from very distant parts, cases which will be more properly considered under other heads. Tuberculous abscesses are best treated by transfixing them in the direction of their long diameter, and dividing them completely by a single stroke of the knife. In those which mount above the sphincter without extending far from the coats of the anus, M. Velpeau recommends a bistoury to be carried into the anus, so as to divide the cavity from within outwards, toward the nates; a plan attributed to J. L. Petit, and which may sometimes prove convenient.

In those cases of phlegmonous abscess seated in or above the levator ani, and which are detected by the introduction of the finger per anum, before they have perforated the aponeuroses and become visible externally, there is no question of the propriety of the plan advocated by the author just mentioned, which consists in sliding a bistoury laid flat, along the left finger, to the seat of the swelling, and then opening the abscess from the rectum by turning the knife, without dividing the sphincter. Of course, the bistoury used for this operation should be guarded through a considerable portion of its length, to prevent injury to the lower part of the canal. The danger of forming a blind internal fistula is not considered a valid objection to this mode of treatment by M. Velpeau, and a patient on whom he operated in 1828, by making a large opening, recovered completely in eight days. (*Dict. de Méd.* III. 313.)

The great difficulty attending the treatment of the other large abscesses of the anus is the extensive denudation and thinning of the rectum and integuments, and the frequent occurrence of a primary or secondary opening in the parietes of the intestine, which admits of the constant introduction of portions of fecal matter. The former circumstance renders cicatrization difficult, by retarding or preventing the formation of granulations over a considerable portion of the parietes of the cavity, and the latter endangers the formation of a fistula, or may cause a succession of new abscesses.

These considerations induced Faget (*l'aîné*) to urge the propriety of invariably dividing the rectum, from the highest point of denudation, to the anus, at the same time that the abscess is opened, so as to throw the two cavities into one. It has also been advised, by others, that any portions of intestine or integument which are so far enfeebled as to retard the union, even when divided, should be removed at once—and Faget himself successfully extirpated an inch and a half of the rectum, for this purpose, without producing incontinence. M. Foubert published soon afterwards an essay in opposition to these views, advocating the propriety of simple punctures without involving the intestine, defending his views by details of several successful cases, only three of which are strictly relevant. The opinions of these writers have divided the profession until recently, and have had perhaps more weight than they justly deserve, for the number of their observations is very small. It is now well known that abscesses of the anus, whether arising from internal or external causes, are often totally unconnected with the intestinal canal, even after they have denuded the rectum to a great extent; and the cases are numerous, in which external incisions, and the evacuation of the pus, have been followed by prompt and complete cures. (Marchand, Sabatier.) Even when there exists such a communication, it is generally located at no great distance from the anus, and by no means requires the extensive division recommended by the former surgeon. (Boyer.) Moreover, fistula is not in all cases a necessary consequence of such a communication, and the consecutive operation rendered necessary by this complication when it does take place, is not now considered of as much importance as it formerly was. On the other hand, surgeons now recommend extensive incisions instead of the simple puncture, of M. Foubert; for instead of increasing the danger of exhaustion and of excessive irritation, by making a free orifice, we actually diminish it. The quantity of the pus secreted, as M. Velpeau very justly remarks, depends not on the extent of the opening, but on that of the cavity, and its irritation is rendered infinitely more severe by the confinement of a portion of pus in the cavity after having undergone the partial action of the air, than by the exposure of the whole surface. M. Mar-

CHAND attributes many of the cases of consecutive abscess, so much feared by M. FAGET when the integrity of the rectum was preserved, to the habit of making too small an opening and then interrupting the flow of the discharge by improper dressings.

It is now conceded, that when the abscess is not very extensive, when it is in close proximity to the anus, and does not rise above the sphincter, the method of M. FAGET is in some degree preferable; that when it is larger, and its communication with the rectum is easily detected, the intestine should be laid open from the internal orifice down to the outlet of the anus; but that when the communication is placed very high in the canal, or when it escapes observation, the external incisions alone, should be practised.

The best position for the patient during the operation is either that recommended in fissure (see § 11.), or that commonly employed in fistula (see § 14.). The nates being sufficiently parted by an assistant, and the form of the incision determined, the surgeon introduces his bistoury to the proper depth, and enlarges the orifice by retracting it. He then introduces the index finger of the left hand into the cavity to examine the condition of the integuments and the intestine, and to ascertain if there is a necessity for any additional incisions for the removal of *culs-de-sac*, or other obstacles to the flow of the pus. If the abscess is stercoraceous, it may be proper to introduce the other index finger into the rectum at the same time, to detect, if possible, the seat of the internal orifice. The wound should be the most dependent part, and, if practicable, it ought to be at least coextensive with the cavity. The only dressings required are, a pledget of lint applied in such a manner as to secure a union from the bottom of the cavity, and to prevent the formation of partial, or irregular adhesions; a poultice: and a double T bandage to support the whole. After a short time, the case may be treated as a common wound. The cure generally requires from six weeks to two months; and after a few weeks have elapsed, the patient should be placed on a generous diet. Free air, if possible, in the country, and every safe measure calculated to produce embonpoint should be employed. All surgeons agree in laying great stress upon this rule in the treatment both of abscesses and fistulæ, as the increase of adipose matter is of powerful assistance in approximating the parietes of the cavity formed by so great a loss or condensation of substance.

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See also the general treatises on the diseases of the anus and rectum, and the Bibliography of § 4. and § 6.

§ 14. *Fistula in Ano.* This term is applied to many suppurating excavations about the anus, which do not come strictly under the definition of Fistula (q. v.) as generally described by authors; for although the disease is sometimes found to consist in a long, narrow, and tortuous ulcer opening upon the integuments by one of its extremities, almost always surrounded by some callosities, and often by very extensive induration, it is not unfrequently dilated into one or more caverns, either confined to the neighbourhood of the rectum, or extending in other directions through the cellular membrane of the pelvis. Sometimes it appears as a considerable cavity with many outlets

(***cavernous abscess***); at others, as a sinuous canal, with several ramifications all finally terminating in one orifice (*sinuous ulcer*). The discharge from this cavity is generally small in amount, and presents the characters of pus, gleet, sero-purulent, sanguineo-serous or mucous matter, according to the condition of the patient's health, and the length of time during which the affection has subsisted. Fistula in ano, then, is a suppurating cavity of considerable extent, seated in the neighbourhood of the anus or rectum, varying in form, having little tendency to become spontaneously obliterated, but continuing for a long time to discharge its secretions through one or more narrow openings in its parietes.

1. *Causes of Fistula.* As this complaint is almost, if not always, preceded by abscess, it may originate from all those causes, whether local or constitutional, which have been enumerated in the preceding section; but of these, by far the most frequent are the irritations giving rise to the tuberculous form of abscess, hemorrhoids, and the arrest of foreign bodies in the lower part of the rectum. Caries of the vertebra, sacrum or coccyx, &c., are more rarely productive of fistula in this region; but there are many cases of this nature on record. Dr. Dorsey relates a very remarkable one, in which a psoas abscess terminated near the anus, was opened, discharged a gallon of pus, became obliterated, but left a fistula which required an operation for its relief. (*Elem. of Surg.* II. 160.)

There are two distinct modes in which an abscess may give rise to fistula. In the first place, when it is seated at a considerable depth, as is mostly the case except in the tuberculous or hemorrhoidal variety, there is sometimes a considerable loss or destruction of the cellular tissue around the anal canal; and even if this accident does not occur, there is nevertheless a condensation or induration, produced by the internal adhesions of the tissue, obliterating the cells around the periphery of the dépôt. (See Art. *Adhesion.* I. 211. 2. a.) Now the constriction of the sphincters keeps the parts around the anus continually in a state of moderate tension, except during the act of defecation, and it is evident that when there is a cavity with loss of substance, or indurated walls, in these parts, the parietes cannot be preserved in contact, except by surgical measures. We are not yet in possession of any efficient plan of treatment for this purpose, and the peculiar structure and functions of the anus render it extremely improbable that it will ever be accomplished. Moreover, the induration of the parietes embarrasses the development of granulations, and renders it difficult for the operations of nature to effect that which thus baffles the surgeon.

The same sources of evil exist in the structure of the recto-ischial excavation (see *Perineum*), in consequence of the tension of the aponeuroses by which it is surrounded; but the frequent expansion of the rectal pouch by fæces, the pressure of the movable viscera, acted on by the abdominal and levatores ani muscles, and the flexibility of the deeper aponeuroses of the pelvis, render almost certain the collapse of a cavity seated above the last named expansions, when its contents have been completely evacuated. It is hardly necessary to point out how far these facts tend to explain the frequent degeneration of large abscesses into fistulous cavities; we will merely impress on the reader these obvious deductions, fully borne out by clinical observation; 1st. that fistula in ano arising solely from this difficulty of collapse, seldom extends above the internal sphincter muscle, except perhaps in those rare cases of stercoraceous abscess caused by the escape of foreign matters from the rectum, at a considerable distance from the anus; and 2d. that the simple enlargement of the external orifice of an abscess, once threatening to form a fistula, by no means secures the prompt and entire obliteration of the cavity.

The second mode in which abscess may give rise to fistula is by the protracted lodgment of pus. This is often under the complete command of the surgeon—as it is less directly dependent on the anatomical structure of the region. When an abscess is spontaneously evacuated, the orifice is almost always small and inefficient, except in the gangrenous variety. The pus, instead of flowing out with freedom, is partially retained, and opposes a mechanical impediment to the collapse or obliteration of the cavity: altered and vitiated by the contact of the air, it soon becomes extremely irritating, and produces additional adhesions and induration in the surrounding tissue, until the affection assumes the fistulous character. When the dépôt is large, the existence of partial septa may keep up the suppuration in the deeper-seated parts, and thus prevent the closure of the orifice. When the presence of such septa is neglected by the operator, no enlargement of the outlet can possibly remedy the evil. In fistula following those

unhappy cases of abscess which are the remote consequence of intractable constitutional diseases, such as phthisis, scrofula, syphilis, cancer, &c., surgery, *as an art*, is of little avail in effecting a permanent cure, which, if at all possible, must depend upon remedies addressed to the more pervading disease. It should not be forgotten, however, that fistula in ano may *coexist* with these affections, without *depending on* them, and that there is strong reason to believe that even when the connexion is more immediate, it is not the general disease, but some local symptom, that gives rise to the fistula. Thus, in phthisis, it may result from the ulcerations of the mucous membrane commonly attendant on that disease, when they are accidentally seated near, or within the anus (Bayle, Ribes. *Mém. de la Soc. d'Emul.* X. 114.); in scrofula, from inflammation of a lymphatic gland; in syphilis, from chancre within the verge. We shall have occasion to allude to this subject hereafter. When abscess of the anus arises from caries of the spine, or any other organic change of a durable character in distant parts, it must degenerate, almost of necessity, into a fistula which cannot be cured, even by an operation, until the remote cause is removed, and the supply of pus prevented. There may be an exception to this rule in a case admitting of a counter-opening, by means of which the pus may be diverted from the pelvis.

But there is still another mode in which the retention of pus in an abscess gives rise to fistula, a mode more generally observed than all those above enumerated; and this is by mechanical distension. The spontaneous orifice of an abscess often contracts after it is formed, to such a degree that it scarcely permits the egress of the pus in sufficient quantity to unburden the cavity of the daily secretion; and it remains at all times liable to absolute closure, by swelling from temporary inflammation, the arrest of small portions of hardened pus, the formation of an accidental valve of cellular tissue at the opening, by pressure on the part, or by simple changes of position, &c. As none of these causes are very permanent in their action, the cavity is alternately distended and relaxed, and nature continues her endeavours to contract the dimensions of the dépôt, while some part of its parietes is continually compelled to yield to the occasional distensions. The consequence is that the weaker portion yields, and the abscess travels slowly in the direction of the least resistance, while the induration by which it is surrounded is continually increasing. When the abscess is of the phlegmonous character, and the intestine is denuded, it naturally tends in this direction, and the resulting fistula is located in the immediate vicinity of the rectum, and may ascend to almost any distance along its surface, or even between its coats; but these coats very seldom yield to eccentric absorption. If the abscess is of the tuberculous or hemorrhoidal character, it naturally makes its way inward, immediately beneath the mucous membrane, and outward, between the skin and superficial fascia, assuming the form of true fistula, in that portion of its course which lies below the inferior margin of the internal sphincter, but spreading out, and denuding the intestine, above that spot. We have now under treatment a case of fistula in ano, originating chiefly in this manner, from so slight a cause as the inflammation of a sebaceous follicle on the perineum, near the scrotum, two and a half inches from the anus. The opening of the little abscess which it occasioned, being insufficient for its evacuation, the pus gradually formed a fistulous canal reaching immediately beneath the skin, to within less than half an inch of the margin of the anus. A counter-opening was made at this spot, by another practitioner, and a ligature was introduced, with the intention of dividing the parts by ulceration! A great degree of inflammation and consequent induration resulted from this treatment. The seton was removed, and the sinus laid open in the usual manner, by a surgical friend, but even this did not arrest the march of the fistula; at the conclusion of the operation there was ascertained to be no prolongation of the canal beyond the limit of the incision, but the extremity of the cut next the anus could not be healed. This part being somewhat irritated and occasionally stretched in consequence of the presence of several large excrescences in the neighbourhood, and the discharge of pus being occasionally arrested by the position of the patient, the fistula was very gradually reproduced, and extended after a few weeks as high as the middle region of the anus, following the duplicature of one of the radiated folds of integument. The point of a small probe introduced into the sinus, could then be felt most distinctly beneath the lining membrane of the anus, but no communication with the intestine yet exists, although the very narrow canal has now expanded itself into a broad sac,

above the margin of the internal sphincter. As this extremely simple case has now resisted for months all proper measures of local treatment and regimen, the operation will be repeated, and the excrescences removed, on the first convenient opportunity; the extreme nervous irritability of the patient's constitution at the time, having prevented the last mentioned step, on the former occasion.

When a tuberculous abscess opens spontaneously into the middle region of the anus, the escape of the discharge is rendered difficult by the constriction of the sphincters both above and below the spot; it consequently makes its way with rapidity toward the perineum, and becomes almost immediately obvious to the surgeon. It should never be suffered to become chronic or fistulous. (See § 12.)

We have already spoken of the manner in which deeper-seated abscesses, when neglected after their evacuation, approach and dênude the rectum, becoming fistulous in their progress; the route which the fistula may ultimately pursue in its course to the surface, though dependent in some degree upon anatomical position, is very various and irregular; sometimes angular, or extremely tortuous. It appears to us, that among those fistulæ which arise from local causes in the neighbourhood of the anus, such as branch, or give rise to productions running in different directions toward the deeper-seated parts of the pelvis, owe the permanence of these profound extensions to the arrest of the discharge, by the operation of mechanical causes, rather than to the pathological condition of the tissue in which they are seated; and when sufficient external openings are made to secure the free and continued evacuation of such canals, we cannot perceive the necessity of laying them open *seriatim*, as advised by the warm advocates of the knife, particularly when they are in close proximity to the rectum. We shall have occasion to allude to this question again, when speaking of the treatment. A great many of the causes of fistula, enumerated by authors, being in reality only causes of its almost universal precursor,—abscess,—we must refer to the preceding section for a more detailed account of them. Those cases said to occur sometimes spontaneously, of which the patient himself is unconscious until they are far advanced, are probably the consequence of very small tuberculous abscesses, like that above recorded.

Although we cannot subscribe to the opinion of Percival Pott, that the degeneration of abscess into fistula, after proper incisions have been made, is always attributable to malpractice, there is no doubt that improper stimulating applications to the wound may yet be ranked among the causes of this affection. The remarks of Marchand, upon the influence of dressings which impede the discharge by their mechanical action, are also deserving of attention. (See *Bibliography* of § 12.)

The concussions occasioned by efforts in leaping, riding, &c., acting as they do upon the whole amount of blood in the portal system, which is unsupported by venous valves, often produce injuries of the vessels and embarrassment of the circulation about the anus, and are therefore an important remote cause of fistula in ano. Hence the remark of Heister (*Inst. Chir.* Cap. clxviii. 4.), that the disease is very common among troopers, and the universal observation that it is one of the peculiar evils attendant on the practice of medicine in country situations.

2. *Varieties.* When a fistula has communication both externally, on the integuments, and internally, into the anus or rectum, it is termed *complete fistula;* but when it opens only onto the surface, or into the canal, it is called *incomplete.* When, in the latter case, there exists no communication with the intestine, it receives the name of *external blind fistula*, and when there is no superficial outlet, it is denominated *internal blind*, or *occult fistula.*

Some authors are said to deny the existence of external blind fistula, believing that there is invariably an internal opening, even when, in consequence of the small dimensions of the passage, it cannot be detected by the probe. (Foubert, Sabatier, Larrey.) We have carefully examined these authorities, and find that although they endeavour to establish the great frequency of complete fistula, their language scarcely appears to bear out the rigorous interpretation put upon it by other writers. (Boyer, Velpeau.) Be this as it may, it is now impossible to doubt the occurrence of such sinuses, in the face of all the evidence from the days of the Hippocratic physicians, to the present time. The authority of Mr. Pott alone would almost suffice to determine the point, independently of the positive proofs obtained by Boyer, from *post-mortem* examination. (*Mal. Chir.* X. 109.) There is nothing in the anatomical or physiological character of the part which can in any manner render it exempt from an affection, common in all places near the surface, where free

cellular tissue is somewhat plentiful. The position of Larrey, that all complete fistulæ, except such as result from wounds, advance from within outwardly, is altogether untenable (*Mémoires.* II. 372.); even when the abscess which gives birth to the fistula is occasioned by an ulceration or the presence of a foreign body in the rectum, it does not necessarily become complete or stercoraceous; for it is well known that such accidents give rise to adhesions in the surrounding parts, and that a submucous abscess may be produced by the inflammation of contiguous tissues, without destroying those adhesions. The great comparative frequency of complete fistula cannot be denied; but this is readily explained by the fact that considerable denudation of the intestine is so commonly attendant on abscess of the anus, and that this denudation is generally located where there is great danger of disruption of the unsupported parietes during defecation.

The existence of occult fistula has also been denied, and with more appearance of reason; for when the primary abscess is seated in or above the levator ani muscle, the orifice is dependent, and the difficulty of closing the cavity does not exist in full force; as has been stated in the last, and the beginning of the present section; and when it occurs immediately beneath the lining membrane of the anal canal, it almost always effects an external opening in a short time. Yet there is ample proof that such abscesses sometimes become chronic; enduring indefinitely, when neglected by the surgeon, and continuing to discharge their contents into the canal. They are reduced, says Velpeau, to the condition of cavernous ulcers, but the discussion in relation to their existence has become a dispute about words. (*Dict. de Méd.* III. 318.)

In regard to their form and number, fistulæ in ano differ materially. We often observe one on each side, in the same patient; not unfrequently, there are several external sinuses, all converging toward one intestinal orifice; much more rarely, there are several communications with the rectum or anus, and sometimes the internal and external orifice of a simple fistula, are found on opposite sides of the mesial plane. Of the indefinite cavernous extensions with which the case is occasionally complicated, we have already spoken.

3. *The seat of the internal orifice* of fistula in ano, has been much debated of late, and the question is one of too much practical importance to be passed without notice. The various plans of operating, and the form of the instruments employed for the cure of this disease, from the earliest times, clearly show that the communication has been supposed to take place in many cases, at a considerable distance from the anus, and sometimes so high as to be beyond the reach of the finger. The language of Sabatier, in his work on operative medicine, leads to the inference that he considered the most frequent causes of fistula to be such as produce perforations in the anal canal; his pupil, Ribes, attributes to him opinions still more exclusive, and adds the result of eighty observations confirming the position that the internal orifice is almost invariably discovered very near the anus, being generally visible externally, on careful examination, and *never* more than five or six lines above the junction of the skin with the mucous membrane. (*Loc. Cit.* 135.) He admits that ulcerations seated in the lower extremity of the rectum, are among the causes of fistula, but denies that they produce such consequences when more distant from the outlet. (Ib. 115.) Yet it is somewhat singular that this writer should include among the cases which Sabatier and himself considered as past the aid of surgery, admitting no other treatment than careful attention to cleanliness, "those of which the internal orifice is placed beyond the reach of the finger." (Ib. 139.) Larrey declares in equally strong language that the seat of the internal orifice is always between the sphincters, in the middle region of the anus or below that place. (*Mémoires.* II. 373.) Velpeau has observed thirty-five cases with the view of determining this point. In four instances, the orifices were found from the height of one and a half, to that of two and a half inches, "consequently a little above the *external* sphincter," says this author; but if we judge from the ordinary dimensions of the anus, all these openings must have been above the margin of the *internal* sphincter, and some of them, nearly as high as the upper extremity of the canal. In a fifth case, the orifice was elevated more than three inches, and the finger reached it with difficulty. The others opened very near the lower end of the canal, three of them being seated below the external sphincter, or almost externally. It is stated that Richerand subscribes to the opinions of Ribes; and the honour of having been the first to propagate them is claimed, by Pleindoux, for Brunel, a physician of Avignon, who ad-

vanced them in 1783. (*Ephémèr. de Montpellier.* VIII. 210.) On the other hand, the frequent occurrence of fistulous communication with the rectum, far above the anus, and sometimes beyond the reach of the finger, is asserted by nearly all the authorities, from the earliest times, down to those of Dessault. It is now universally conceded, if indeed it ever was denied (see Heister. *Inst. Chir.* Cap. clxviii.), that the orifice is seated, in a vast majority of instances, within the anal canal; commonly in its middle region, often in its superior part, and not unfrequently in its lower portion (see Art. I.). Yet it is not less true that occasional cases of much greater elevation of the orifice have occurred to most modern surgeons. We do not recollect to have met with any exception among English authorities; and we may add to the high testimony of Roux and Boyer in favour of this position, that of all the distinguished American surgeons with whom we have conversed.

The very great frequency of mechanical injuries resulting from the action of fæces and extraneous substances on the mucous lacunæ and wrinkles of the upper region, and on the parietes of the middle region, the ulceration of hemorrhoidal veins, so strongly insisted on by M. Ribes, the inflammation sometimes produced by similar causes in the preternatural pouches of Dr. Physick, when they are present, and perhaps in the sacculi, of Horner, when diseased, are quite sufficient to account for the fact that in a great majority of cases, the orifice is found to be situated as several of the authors quoted have described, and the practical inferences which they have drawn from this fact are certainly highly valuable. The enlarged form of the great pouch of the rectum, the flexibility of its occasional transverse folds, and the comparatively slight tendency of the fæcal matters to escape, when the parietes of the intestine are ruptured above the commencement of the anus, explain, not less satisfactorily, the rare occurrence of fistula with an opening more deeply seated.

Ribes and Larrey narrate some most interesting cases, of gun-shot wounds in which balls have penetrated the rectum and have been afterwards discharged per anum without producing fistula; and in one of these, observed by the former, a portion of the dress, carried in by the ball, but lodged exterior to the intestine, gave rise to abscess of the anus and was discharged with the pus; yet the dépôt did not at any time communicate with the canal. Notwithstanding this fact, there is sufficient evidence to show that the rectum may be penetrated at any height, either by foreign bodies or ulceration from within, or by the destruction of its walls in the progress of abscesses from without. The occasional existence of strictures, or of partial mucous septa in the intestine, must necessarily increase its liability to such accidents. (See *Rectum.*)

The depth and extent of the sinus have no fixed relation to that of the internal orifice of the fistula, for a probe may be sometimes passed with the utmost facility for many inches, either between the coats of the rectum or in other directions, while the communication with the anus is close to the extremity of the canal. Larrey ventures to attribute the cases in which the orifice is more deeply seated, to the unintentional puncture of the intestine by the probe, in search of that which has no previous existence; and the facility with which the blunt bistoury often enters the rectum, in the operation of Pott for incomplete external fistula, proves that such an accident might easily occur to a careless surgeon.

4. *Diagnosis.* External fistula in ano, whether complete or incomplete, is not always detected without careful examination. When it is large, and surrounded by extensive induration, it is easily recognized; if it is preceded by an abscess of considerable size, the nature of the complaint cannot be mistaken; but when its dimensions are small, and when, as often happens, it has continued for some time before it attracts attention, the orifice is occasionally hidden between the radiated folds of the margin, or lies concealed at the bottom of a little follicular depression; not unfrequently it is covered by a slight crust or scab, and it may even become regularly cicatrized from time to time until the accumulation of pus in the sinus again forces an outlet. The patient complains that his linen is continually soiled by a discharge which he often attributes to hemorrhoids: the stain is sometimes sanguineous, more frequently sero-purulent, generally serous or mucous, and rarely presents the characters of true pus. It is often very fetid, and sometimes mingled with stercoraceous matter. By strict attention the situation of the external orifice may always be discovered, though it is sometimes extremely minute. On the introduction of a probe, the instrument usually takes a direction at first toward the anus, and then upward along the rectum, but this is not invariably the case.

Those instances of fistula which extend toward the recto-ischial excavation, or toward the nates or perineum, without ever approaching the intestine, differ in no respect from similar affections of other parts, and should be treated in a similar manner (see Art. *Fistula*); but besides these there are some, so angular or tortuous that they travel in the first instance in a course very different from that by which they ultimately approach the canal; and others, which mount almost directly upward through the sphincter externus, or beyond its edge. In most cases, the route of the probe may be readily traced by the finger when introduced into the rectum, the point being felt, at first, immediately beneath the integuments of the middle and lower portions of the anal canal, and afterwards ascending to the height of one, two, three or more inches along the rectum, until it reaches the extremity of the *cul-de-sac* formed by the denudation of the intestine. Sometimes it is only the mucous membrane that intervenes between the probe and the finger; sometimes the instrument passes outside of the internal sphincter, or through its substance, and the septum includes all the coats of the rectum. In the cases in which the fistula penetrates, or lies beyond the external sphincter, it is sometimes separated to a considerable distance from the intestine, and the septum may be so indurated that the probe is obscurely felt.

It is often much more difficult to determine the difference between a complete and an external blind fistula. If portions of solid fecal matter, ascarides, or foreign bodies, are from time to time evacuated from the sinus, the case is indeed obvious, and the escape of wind, by the same route, is scarcely less conclusive; but a dark colour and stercoraceous odour of the discharge, are not a sufficient proof of the existence of an internal orifice, for reasons already noticed in the preceding section; neither does the absence of all these appearances furnish positive evidence of its nonexistence. Even exploration by the probe does not always determine the point, for the sinus may branch or may be connected with cavities extending in various directions; its course may be so tortuous that it cannot be thoroughly traced, or it may be interrupted by partial septa which arrest the instrument. Still this mode of investigation will generally succeed, if the fistula is complete, and if due attention is paid to the fact that the internal orifice is almost always near the extremity of the anus. It is proper to carry the instrument in the first instance directly toward the margin, if there is any vacuity in this direction; and having fully ascertained that the outlet is not situated in the lower portion of the canal, the surgeon should introduce an index finger into the anus, and continue his search by causing the point of the probe to traverse all the denuded portion of the parietes of the middle region between the sphincters, where it will be felt with the utmost distinctness if the fistula has taken this route. It must be borne in mind, however, that even when the instrument has entered the canal, it may not always come into contact with the finger without considerable manipulation, because the point may still be covered by the smooth walls of the sacculi of HORNER, or the mucous lacunæ of the part.

For thus much of the examination, a small blunt silver probe is better than any other, but it must be suffered to enter without force, or, as if spontaneously, for slight pressure is sufficient to break down the very delicate cellular connexions between the integuments and the parts beneath; and even the former sometimes yield very readily.

Having ascertained as clearly as possible that the orifice is not seated below the margin of the internal sphincter, the surgeon should examine with great care, the parietes of the superior portion of the anus and the neighbouring parts of the rectum, before attempting to trace any farther the course of the sinus. In many instances a little papillary eminence points out the site of the opening, and even when this does not happen, the unusual sensibility of a particular point leads to a probable conjecture as to its location. In either case, a valuable guide is obtained for the direction of instrumental researches. In exploring deep sinuses, it is often, perhaps always, advisable to employ a delicate, flexible probe; particularly when the fistula extends beyond the reach of the finger. Much care is required in this operation, and it may even be doubted whether we should seek at all for the internal orifice in such cases, unless the positively stercoraceous character of the discharge undeniably determines its presence: this question will be argued hereafter. When changes of direction in the superficial portions of the sinuses interfere with the proper exploration, such parts should be laid open by the bistoury, without hesitation.

If no orifice can be detected by means of the probe, it has been advised, from

early times, that tepid injections of water or mild, coloured fluids should be injected into the fistula; the return of which, by the anus, is a decisive proof of its completeness. This plan may be advisable in certain cases; but there is little gained by the discovery of the *existence* of an intestinal orifice, unless its *location* is likewise ascertained.

External fistula, once discovered, is little likely to be confused with any other affection, except, perhaps, the urinary fistula, which sometimes opens near the anus, and may even cause denudation of the rectum. In the last case, the obviously urinous smell of the discharges, so strongly diagnostic of the latter disease, may be obscured by the transfusion of a stercoraceous odour; but the flow of urine from the outlet, during the act of evacuating the bladder, furnishes all the evidence required to distinguish it from the former.

The diagnosis of occult fistula is somewhat more difficult. The symptoms of the abscess in which it generally originates, having subsided (see § 13.), there remain a slight degree of soreness, and a purulent discharge from the anus, which coats the fæces in their passage. The patient attributes these symptoms to internal piles, and seldom consults the surgeon until the disease has continued for a long time. If the practitioner is contented with a careless examination, as happens but too frequently in anal disease, the pain and the discharge may be considered as the result of ulceration in the rectum, blenorrhagia, hemorrhoids, &c. The previous history of the case may prevent such mistakes when the fistula has been occasioned by a considerable abscess; but it may also occur from follicular ulceration, disease of the sacculi of Horner, or inflammation of the preternatural pouches of Physick, without those severe local and sympathetic inconveniences that characterize abscess pointing internally. Referring the reader to other heads for many remarks on this subject, we will merely mention that occult fistula almost always produces changes obvious externally. Commonly there is a distinct hardness or small tumour at the margin of the anus; not unfrequently there is some softening in the centre of this hardness, with a red or livid spot, beneath which, the integuments may or may not be thinned by ulceration; and, if pressure be made on this tumour, an increased discharge of pus takes place from the anus. These signs can hardly be presented, if true occult fistula is seated in or above the levator ani muscle, as M. Velpeau supposes sometimes to happen. The finger, introduced into the rectum, often perceives the location of the orifice, as in complete fistula; but the most positive evidence is obtained by means of the bent probe of Dionis and Heister, employed as directed in § 12.

5. *Prognosis.* The prognosis of *simple fistula in ano* is almost always favourable. The principal exception to this rule is in the case of complete stercoraceous fistula, when the intestinal orifice cannot be detected or obliterated, for the constant passage of fecal matter then removes all possibility of cure. Another exception is made by most writers, with regard to those simple fistulæ which penetrate the perineal and pelvic aponeuroses, and are connected with extensive cavities passing in various directions toward the deeper parts of the pelvis. That some such cases may be incurable in their nature, there is little doubt; but whenever it is possible to make and preserve a free outlet for the purpose, the powers of nature are never inactive in limiting the extent of the disease. The adventitious mucous membrane which forms the lining of all fistulæ, (the existence of which, discovered by John Hunter, is now no longer doubtful,) has a constant tendency to contraction, and it is not unusual to see the extent of old and considerable sinuses greatly diminished by this means, even when very little assistance is rendered by the surgeon. That the extent of the suppurating cavity is not an insuperable bar to recovery from this disease, is most clearly shown by the fact that cures have been effected, in cases of psoas abscess connected with fistula in ano. We have already quoted an instance of this kind from the late Professor Dorsey. It should not be forgotten that the parts above the deeper-seated fasciæ, are precisely those in which there is the least mechanical resistance to the approximation of the sides of the cavity under abdominal pressure.

Though a vast majority of cases continue during life, unless the aid of surgery is invoked, it is no longer questionable that fistula in ano, when not stercoraceous, may recover spontaneously. Many cases of this kind have been noted by different writers; suffice it here to mention the names of Pott, Ribes, and Velpeau, as among the number. They have yielded to country air and exercise, and to such a regimen as is calculated to induce embonpoint. These exceptions to a general law have, however, but little value except

to prove the importance of regimen as a coadjuvant in the treatment of the disease.

On the subject of the prognosis, in fistula in ano complicated with other local or general affections, such as caries of the spine, scrofulous abscess, cancer, syphilis, phthisis, &c., little need be added to the remarks already made under the head of *causes*. When the fistula proceeds from either of these complaints, it is obvious that the former cannot be eradicated until the latter is cured; it is then reduced to the condition of simple fistula; hence, when the primary affection is incurable, so likewise must be its consequence. We may add a few words on the subject of the connexion between phthisis and fistula. There is an opinion very popular both in and out of the profession, that it is wrong to attempt the cure of the latter disease in persons who are predisposed to consumption; but the researches of Laennec and Bayle do not support the position. MM. Roche and Sanson have ventured to assert that the belief in the connexion between these complaints is now almost abandoned, but this is scarcely warrantable. M. Ribes has come to the conclusion that fistula is associated with phthisis in two different ways, firstly, as a contemporaneous, but independent accident, in which case the prognosis is not less favourable than when there exists no complication; and secondly, as a consequence of one of the sympathetic symptoms of this disease, namely, ulceration of the mucous membranes, which are sometimes seated near the anus. Under the latter circumstances the permanent cure can hardly be expected. M. Velpeau remarks that the attempt at cure is not productive of injury, in consumptive patients, but that success is almost always impossible: the wound continues soft and pale, and the suppuration intractable.

6. *Treatment.* The plans of general treatment required in fistula in ano are so various, and so completely dependent upon constitutional peculiarities, or accidental complications of the disease, that it would be useless to discuss them here. They all tend to effect the same purpose, namely, the restoration of general health, vigour, and embonpoint, and must be conducted on well-known principles, according to the condition of each particular patient. The object of all local treatment is the obliteration of the abnormal cavity; but the modes recommended by different writers for accomplishing it, are so numerous that the mere analysis of them is a task of difficulty. It is not our design to make a vain display of learning by enumerating all the measures formerly in vogue, and we shall confine ourselves to the consideration of such as are still in use, either in their original, or in a modified form; referring the curious reader to the *Bibliography* of this section, for information of a purely historical character. Our remarks on the several operations and instruments will be preceded by some general observations on the causes of difficulty in the cure, and the means of overcoming them.

a. *The forces which oppose the obliteration* of a fistula in ano, when free from complication, are four in number. Two of these are mechanical; 1st. the changes in the relation between contiguous parts in the immediate neighbourhood of the anus, produced by the habitual tonic contraction of the sphincters, their frequent dilatation, the descent of the superior portion of the canal in defecation; the unyielding character of the bony walls of the pelvis; and the effectual resistance offered to the descent of the viscera under abdominal pressure, by the levatores ani muscles and the pelvic and perineal aponeuroses: 2d. the permanent lodgment of pus in the sinus, occasioned either by the existence of partial septa and great inequalities of surface, or by the insufficient dimensions of the external orifice: a 3d force is purely physiological, and consists in the peculiar vital condition of the parietes of the sinus, which are sometimes covered with unhealthy fungoid granulations, as remarked by Mr. Pott, and more frequently converted into the pseudo-mucous membrane of which we have already spoken; both these changes of structure are insuperable bars to the formation of secure adhesions: the 4th force is peculiar to the true stercoraceous fistula, and consists in the frequent passage of intestinal secretions and excrementitious matter through its canal. The action of this cause is of a mixed character. It not only occasions frequent mechanical distension of the sinus, but lessens its natural tendency to contraction; for it is found that fistulæ or sinuous ulcers communicating with secretory or excretory ducts generally continue less manageable than those which have no such connexion, even after the natural route of the discharges is fully re-established—hence one of the great difficulties of curing salivary fistula.

With regard to the first of these causes, it is well known that when the contact of the parietes of a truly fistulous cavity is mechanically prevented, nature makes no effort towards its obliteration by granula-

tions, unless the character of the accidental membrane lining the sinus is changed by surgical measures. This change may be accomplished either by stimulating and caustic injections, or by laying open the canal, so as to convert it into a simple suppurating wound. If the former means be employed in the disease of which we are now treating, there is no method by which we can effectually control the action of the muscles, and the consequent separation of the walls of the cavity, at least in some part of their extent; the pseudo-mucous membrane is almost always reproduced, the disease continues, and is not unfrequently rendered more important by the loss of substance occasioned by the treatment. But in those parts of the track of a fistula in ano where no tendency to separation exists, this mode of treatment may be beneficial in certain cases: it is therefore important to determine what parts are thus exempted. We have already stated the opinion that all cavities seated above or within the levatores ani muscles are closed by abdominal pressure, when completely evacuated. There is little reason to anticipate difficulty in the approximation of the parietes, even in sinuses lying between these muscles and the middle fascia of the perineum; for the contraction of the levators, which alone could tend to produce a separation, scarce ever takes place except during defecation, when the sphincter externus is proportionably dilated, and when the abdominal pressure is greatest. (See Art. II.) The same cause is equally efficient in favouring the contraction of cavities seated in the meso-rectum, or between the sacrum and the intestine; and when the mucous coat, or the entire walls of the latter are denuded, at any point above the superior extremity of the anal canal, the perfect flexibility of the membranes, and the mobility of the adjacent organs, preclude the possibility of any vacuity from changes of relation among the parts in consequence of muscular action. If these physiological views are correct, difficulty in the treatment, arising from the cause under discussion, can only occur in the interval between the two sphincters, and in the recto-ischial excavation. It follows then, that granting the occasional propriety of injections to produce adhesion in those sinuses or excavations which penetrate beyond the fascia media, they are not dependable in the treatment of fistulæ or parts of fistulæ which are situated more superficially.

We have dwelt at sufficient length upon the second-named force which opposes the obliteration, when speaking of *causes;* but the *third* demands some farther comment. The same vital laws which cause the formation of the pseudo-mucous membrane of a fistula and the suppurating tunic of an abscess, whenever their presence is required, as certainly insure their destruction after the cessation of their functions. Both these novel formations have a strong tendency to contraction, and both, having once completed their duties, are speedily reduced to common cellular or cellulo-fibrous tissue. The latter is, however, an active agent in the process of granulation, and cannot be made to disappear, until that process is completed by the formation of a cicatrix: the former, on the contrary, is already cicatrized; it is a portion of spurious internal integument, differing in no essential manner from an excretory duct; it is always the passive conduit of some secretion, and must disappear when no longer employed. Unfortunately the mucous discharge from the membrane which lines the canal is often sufficient of itself to secure its perpetuity.

Now, in extensive fistula in ano, unless when very long continued, the deeper-seated parts are generally in the condition of an open abscess or cavernous ulcer, capable of contracting by granulation, and equally liable to assume the fungous character described by Pott. It is needless here to state how easily parts in such a condition may be modified and benefited by local applications. (See *Ulcer.*) The more superficial portion of the sinus, on the contrary, is generally lined with pseudo-mucous membrane; and as it is almost impossible to arrest entirely the passage of the discharges, it follows that even if the mechanical causes which oppose the cure were absent, the success of any local applications would be very doubtful; but when it is considered that all these causes act together, and with peculiar force upon the lower portion of the sinus, there can be no difficulty in understanding the fact that the only certainly effectual mode of curing the disease is the complete division of the parietes in at least so much of their extent as lies below the superior margin of the external sphincter. The occasional though very rare occurrence of spontaneous cures, the very strong testimony of Pott, and the numerous cures of extensive fistulæ by Sabatier, Ribes, Larrey, Lawrence, Syme, &c., when incisions have been carried no higher than the point indicated, although the denudation of the rectum had taken place to a great

extent, are sufficient to place beyond dispute the position we have been endeavouring to prove, and explain, that the difficulties which oppose the cure of fistula in ano without an operation are mainly confined to the lower part of the sinus, and hence, that the long incisions of the rectum still so frequently recommended and practised, as well in external as in complete fistula, are of very doubtful necessity.

Those cases in which there are, at the same time, an extensive denudation of the rectum, and irregular and deep-seated sinuses which retain a portion of the pus, form only an apparent exception to this law; for the division of the parietes of the anus alone, is amply sufficient for the evacuation of such discharges as can be effected by any surgical measure of the kind. It is right, under these circumstances, to divide all partial septa within reach of the knife, but the extension of the opening in the walls of the rectum can have no beneficial effect.

A true stercoraceous fistula, with an internal orifice placed high up in the canal, is indeed an exception, and for obvious reasons. Nothing short of a complete division of the sinus from the internal to the external orifice can be depended on for the cure of stercoraceous fistula; but the cases are rare in which the communication with the rectum is located far above the anus, and those in which a communication so placed gives admission to stercoraceous matter are still more rare. The mere fact of a fistula being complete, when it is not traversed by intestinal matters, is not in itself a sufficient reason for carrying an operation to a dangerous or very troublesome extent, for the internal orifice may heal, when the external outlet gives free exit to the discharges. With these remarks premised, we will pass to the consideration of the different methods and instruments employed in the treatment.

b. *Method by regimen and local applications.* The records of surgery, from the days of Avicenna to those of Le Dran, contain recommendations of numerous local applications, baths, mineral waters, &c., for the cure of fistula in ano; there is scarcely an article now employed in the treatment of ulcers, unless of modern discovery, which has not had its advocates either in or out of the profession; but many of these boasted panaceæ received their death-blow in failing to arrest the progress of the disease in Louis XIV. Still we occasionally meet with cases of success by such means, in more modern annals. Pallas was an advocate for this method of treatment, and Evers recommends the injection of gum ammoniac. Two cases are stated to have been cured under the use of mercury, by Dr. Potter (*Baltimore Med. and Phys. Journ.* I. 119.), and the frequent attempts still made by most practitioners before proceeding to an operation, are a sufficient proof that the idea of success by this method is not yet wholly abandoned. It is by no means difficult to appreciate the just value of such measures, but all detail of the various remedies employed would be misplaced in this article. The few cases of spontaneous cure will not warrant the hope of eradicating fistula in ano by treating it as a simple sinuous ulcer; but the attempt may diminish the extent of the disease in bad cases, and simplify very greatly the necessary surgical operation. This fact appears to have been neglected by all writers on the subject.

We may mention as varieties of this method, the plan of dilating the orifice by means of tents, and that of introducing setons to irritate the sinus, both of which are now justly discarded. Had the idea suggested itself to the advocates of the former method, that the introduction of tubular, instead of solid tents would have secured instead of arresting the free discharge of the secretions, the consequences would have been more happy; and we are by no means sure that this plan might not be acted upon with advantage in extensive external fistulæ, the canula being introduced for a short distance, and there retained until the deeper portion of the cavity has been allowed to contract, when the cure could be readily completed by other means.

c. *Method by caustic.* Two causes conspired to render this method popular, from the time of the earlier Alexandrine writers, to the conclusion of the middle age of surgery. These were, firstly, the mistaken idea that the indurations with which fistulæ and abscesses are often surrounded require to be maturated and removed before the parts can be reunited;—an idea which we should consider as belonging only to the history of the science, were it not for some scarcely ambiguous traces of its practical influence exhibited in the writings of certain more recent French surgeons;—and secondly, the dread of the knife, so natural in the infancy of anatomical knowledge. In modern times, the method by caustic is resigned to the empyrics, or if used by regular practitioners,

it is only in culpable condescension to the unfounded fears of the patient, and even then it is only employed as a substitute for the knife in laying open the canal or in removing partial septa. It may be wrong to condemn it in every case and under all circumstances, for the destruction of the pseudo-mucous membrane in this manner might facilitate the recovery under the measures of which we are now about to speak, if these measures should hereafter receive the sanction of the profession.

d. *Method by excentric compression.* This very ingenious method consists in distending the anus and pouch of the rectum in such a manner as to close the internal orifice, if the fistula is complete, and to remove the mechanical forces which oppose the obliteration of the sinus. The first proposition of this method is due, according to Velpeau, to M. Bermond of Bourdeaux. It consists in two concentric metallic canulæ, the external one covered with some tissue (*une double canule à chemise*), which is introduced empty and closed into the anus. Lint, sponge, or some other suitable substance, is then introduced between the external canula and the cover, until the rectum is sufficiently distended, and the whole apparatus is supported by suitable compresses and bandage until the sinus has cicatrized. When a stool is required, the internal canula, which ends in a cul-de-sac, is withdrawn, and the external one remains open at both ends, for the passage of fæces or the administration of injections if necessary. (*Thèses de Paris*, No. 44. 1827. p. 23.) M. Colombe, about the same time, employed for a similar purpose a hollow cylinder of ebony or gum elastic, retained in the anus by ribbons attached externally. (*Bibl. Méd.* II. 1828.) M. Velpeau, who does not seem to anticipate great advantages from this method, prefers the apparatus of M. Bermond, as he has seen M. Colombe compelled to renounce his plan in one instance, in consequence of a prolapsus of the mucous coat of the rectum into the superior orifice of the cylinder. (*Dict. de Méd.* III. 328.) The success of the method has not yet been sufficiently tested, but we confess our doubts of the possibility of retaining any very considerable mass of compress in the pouch of the rectum for a sufficient length of time. In extensive fistula, whether complete or external, the effect would be prejudicial by retarding the exit of the discharges from the deeper-seated parts. Even if the external portion of the canal and its internal orifice were closed by adhesion, there would be great danger of converting the disease into an abscess or cyst, which would reproduce the fistula. The method seems then to be applicable chiefly to cases in which the sinus does not mount above the superior margin of the internal sphincter; and if the apparatus of M. Colombe could be so modified as to remove the objection of M. Velpeau, it might then perhaps obviate the necessity of an operation, which, however, is by no means severe in such cases.

e. *Method by external compression.* This mode of treatment is difficult and troublesome; it consists in the application of compresses which fill the lower part of the anal canal without passing the point of greatest constriction of the external sphincter, and which are continued over the superficial part of the sinus. They are supported by bandages which act with very little certainty, owing to the form of the parts. The method is still frequently employed, and sometimes with success. It is applicable only to complete fistulæ of which both openings are visible from without, and which have no internal prolongations. It is, even in these, liable to greater objections than the knife, and in all other cases it must prove positively injurious by arresting the discharges. We have noticed it only because we have several times seen it misapplied.

f. *Method by ligature.* This consists in the introduction of a ligature of thread, silk, tape, or flexible metal, which is made to pass through both orifices of the fistula, if it be complete, and also through the anus; or if it be external, a new orifice is made into the rectum as near as possible to the upper extremity of the *cul-de-sac*, and the case is then treated as if completely mature. The two extremities of the ligature, dependent from the external orifice, and from the anus, being tied or twisted together, or included in a single or double canula, the whole septum intervening between the sinus and the rectum is included in the loop. The weight and tension of the cord produce a gradual ulceration of the septum, and this yielding before the pressure, granulations are formed upon the surface of the sinus, which thus becomes obliterated above, as the ligature cuts its way to the surface. The loop is tightened as it becomes slack, and it is thus contracted with a rapidity proportioned to the irritability of the patient and the thickness of the septum.

This method is of ancient date. It is described by Hippocrates (*De Fistula*), and very little improvement has been

made upon his plan of performing it, until within a few years. Although by no means universally employed, the timidity of the earlier surgeons rendered it a favourite practice, down to the days of Dessault, and perhaps it has never been wanting in advocates even since that period. Founded on the fear of hemorrhage, a dread which the light of anatomy has now in great degree removed, it deserved a high preference over most of the rude measures formerly employed in deep incisions, complicated as they were with precautions against bleeding, cruel in their nature, and entirely unnecessary. Perhaps the greatest objection to this mode of treatment as then practised was, its combination with the method by caustic. The ligature is but seldom employed at present. M. Velpeau declares that it has scarce any partisans (*Dict. de Méd.* III. 327.), and Mr. Samuel Cooper says it is justly abandoned in England. (*Surg. Dict.* Art. *Anus.*) The principal arguments against it are the slowness of its action, the excessive pain to which it sometimes gives rise, and the nervous symptoms that occasionally supervene. From three to six weeks are often required for the entire division of the septum, and the sufferings of the patient have been known to compel the surgeon to resort to the knife before the completion of the process. On the other hand, it should be remembered that all these objections apply with most force to the division, by ligature, of the lower part of the septum, where it is covered by the skin and the lining membrane of the two inferior portions of the anal canal. It is here that the ulceration proceeds most slowly, that the sensibility of the parts is greatest, and it is here also that injuries or inflammation produce the most severe sympathetic symptoms (see § 11.); but the very reverse is observed in the parts covered by true mucous membrane, when in a healthy condition. The difficulties above mentioned are by no means observed in every case; we have seen the operation repeatedly performed and completed without occasioning any very serious suffering; much depends on the condition of the patient at the time; and the attempt to apply the ligature, or even to explore the sinus, when the parts are highly irritated or inflamed, is altogether unwarrantable; leeches, fomentations, or emollient poultices, with proper general treatment, should always be premised in such cases. Dr. Gibson strongly insists on this course even when the knife is employed, although the hemorrhage which follows the incision is well calculated to lessen the evils resulting from the introduction of the instruments. (*Elem. of Surg.* II.)

It is in vain to pretend that the hemorrhage is never dangerous and seldom troublesome after the use of the knife in cases which require the incision to be carried high up upon the rectum, where large branches, or the main trunks of the middle hemorrhoidal arteries may be unavoidably cut; and under such circumstances, the method we are now discussing enjoys very great advantages, unless, as rarely happens, the upper part of the septum is thick, indurated, and very unyielding. It is by no means necessary that the operation, though *commenced* by the ligature, should be *completed* by it. Dr. Physick in his lectures, and Dr. Dorsey in his surgery when commenting on the operation of Dessault for very extensive fistulæ, state that it often facilitates the cure to lay the sinus open by incision as soon as the loup has become so far contracted that the whole remaining portion of the septum is within reach of the knife. (*Elem. of Surg.* II. 164.) Within a few days, Dr. B. H. Coates has modified this method in a manner still different. Observing that ligatures applied to mucous membranes divided them very rapidly and with little pain, while those applied to the common integument advanced with difficulty and gave great inconvenience by their pressure, he resolved to commence the operation for fistula in ano by an incision through all the parts between the external orifice, and the edge of the mucous membrane at the lower margin of the internal sphincter, and then to proceed with the division of the superior part of the septum by the ligature. This he effected by passing a sharp-pointed bistoury through the sinus and its parietes at the point specified, to the finger in the anus. After completing the incision in the usual manner, he again punctured the mucous membrane from the *cul-de-sac* of the sinus, somewhat more than an inch higher up in the canal. A wire being carried through this second puncture, and drawn out from the anus, the ends were secured together, and the union of the incision prevented by the dressings. The ligature came away on the fourth day, without having been tightened. The patient is doing well, but, owing to rather extensive attenuation of the skin around the original orifice, the case is still pending. This is another application of the principle upon which rests the operation of Dr. Physick for removing tumours of the anus by ligature (see § 9);

it seems preferable to the plan last mentioned, because it relieves the very sensitive margin of the anus from irritation during the whole progress of the treatment.

In estimating the value of the method by ligature, it is right to mention that no artery of difficult access and important size is seated in the perineum below the fascia media, or in the recto-ischial excavation. The lower hemorrhoidal arteries may be seen and secured, if they should be divided and should bleed profusely, which is seldom the case. The loss of blood consequent on the incision of the part, is generally advantageous to the patient in this disease. The history of the operations for fissure, and the excision of the rectum, clearly shows that bleeding, even from free incisions in the superior portion of the anal canal, seldom demands the interference of the surgeon, and is easily arrested when it occurs. The nature of the operation precludes the danger of occult hemorrhage in fistula in ano which does not extend above the upper edge of the internal sphincter. These dangers furnishing the only pleas in favour of the ligature, this method appears to us inapplicable in fistula which does not penetrate beyond the spot just specified.

If the views which we have given when speaking of external blind fistula extending high onto the rectum be correct, the method is equally inapplicable in such cases; for we hold that the required incision should be confined to that portion of the septum which lies between the sinus and the anal canal; but this opinion is advanced with diffidence, for the weight of authority is against it. (See p. 140.) But the case is widely different when a true stercoraceous fistula opens into the rectum far above the anus; the difficulty of securing any vessel thus situated; the large size of the arteries often involved, particularly if the sinus is located near the posterior part of the intestine; the great danger of concealed hemorrhage; and above all, the directions given by the advocates of the knife, for the arrest of the bleeding in cases of difficulty; render it at least doubtful whether the ligature has not been too sweepingly condemned. Either of the modifications of this method which have been noticed above, are sufficient to exempt it from most of the objections urged against it, and it is certainly much more safe than that of incision. M. Velpeau (*Loc. Cit.*) states that it seldom succeeds when the sinus has several branches, and that even in simpler cases it is not always more fortunate. The same remark may be made of all the methods, and there are not to be found a sufficient number of well-observed cases, to warrant us in making a comparative estimate of their success. The hemorrhage from the use of the knife, in these deeply seated fistulæ, has been known to prove fatal; fortunately they are very rare. We have dwelt more fully upon this subject, because the ligature is not abandoned in this country; perhaps it may be too frequently employed, and it therefore becomes highly important to point out the cases in which it is improper, as well as those to which it is well adapted.

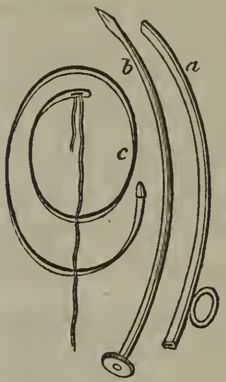
The materials of which the ligature has been formed have been exceedingly various. Hair, bristles, cords of silk, hemp smooth or knotted, &c., were used by the ancients. Foubert introduced leaden wire, which is still in use; other flexible metals, such as silver or annealed iron, have been more recently employed, and tape or strong bobbin is now frequently used. It would be useless to quote authorities on a point of so little apparent importance, but the selection of a proper material is not altogether a matter of indifference. In proportion to the form and nature of the ligature, will be the rapidity of the ulceration it occasions, and also the severity of the irritation it produces—both of which are occasionally important considerations. Of all the materials mentioned, the leaden wire is perhaps the least and the bobbin or cotton cord the most irritating. The metallic wires possess the advantage of firmness, which may enable the surgeon to introduce them in some cases without the aid of any other instrument; but they are more likely, on this very account, to produce mischief to the mucous membrane in the attempt to bring the extremity down to the anus, and they cannot be made to embrace the septum so evenly as more flexible cords.

There have been several modes recommended for the introduction of the ligature, the oldest of which is the Hippocratic. The author employed a blunt pewter eyed probe, which he armed with his ribbon of thread and horse-hair, and passing its extremity into the rectum, he brought it down with the index finger of his left hand placed in the anus; then withdrawing the probe by this extremity, the ligature was carried through the sinus and anal canal—its ends were tied externally in a sliding knot, and tightened as usual, from time to time, until the septum was completely divided. A similar mode is still in

use, except that the probe is now made of silver. The chief objection to it, is the difficulty of bending the extremity of the probe in the rectum, without a very painful traction on the septum. This difficulty becomes greater, when the internal orifice is located high on the rectum; and insuperable, when it rises above the reach of the finger. The advocates of extensive incision in external blind fistula, found it necessary to puncture the rectum at a considerable distance from the anus, in order to use either the knife or the ligature; and we owe to AMBROSE PARÉ the introduction of the canula and stilet for this purpose. He employed a curved tube, through which he passed a long lancet-pointed needle, and with this he penetrated the rectum to the finger introduced per anum. This surgeon, and his pupil GUILLEMEAU, when they used the ligature, employed the curved canula as a guide for its introduction. DESSAULT modified the plan of PARÉ, but rendered it more complex without any material improvement. If the original internal orifice, or the puncture made by the surgeon, was placed beyond the reach of the finger, he seized the ligature when it left the canula, with a forceps of peculiar construction, called a *pince gorgeret*, and he secured the dependent extremities of the wire by passing them through a flattened canula and doubling them upon notches made for the purpose in its lower margin. (*Œuvres Chir.* II. 388.) The use of forceps in the rectum, requires great care, and should not be resorted to without strong necessity; but the method as practised by DESSAULT is still viewed with favour by those who approve of the ligature in very deep fistulæ. Dr. J. K. MITCHELL has invented an instrument which has been sometimes employed for the passage of the ligature. It is a forceps, with long arms, curved at their extremities, and meeting only at their points. These arms are tubular, each forming a steel canula open near the joint of the instrument and at the extremity of the blade. When closed, there is a continuous canal throughout the blades; the joint is formed like that of a midwifery forceps; and the arms are intended to be introduced separately—one into the anus —the other into the *cul-de-sac* of the sinus. The blades being then adjusted, locked, and closed, a long, sharp and flexible steel needle is passed up the canula in the sinus, penetrates the rectum, if necessary, and returns by the canula in the anus, without the possibility of leaving its track, or injuring the surrounding parts. (*Amer.

Journ. of Med. Sciences.* II. 343.) This instrument is certainly constructed with great ingenuity, but there must be much difficulty in the introduction of two such canulæ,—the one, through a canal nearly straight, the other, through a sinus often very tortuous,—in such a manner as to bring the blades of the forceps into proper relation with each other; a difficulty increased by the curved form given to the ends of the arms.

By far the most beautiful plan which we have seen suggested for the introduction of the ligature is that proposed by the present Professor of Surgery in the University of Pennsylvania. We have been politely permitted by Dr. GIBSON to take a drawing of this instrument, intended only for deep-seated fistula in ano, such alone requiring the ligature. It consists of, 1st,



a flat silver canula (*a*), slightly curved, about five inches in length, $\frac{1}{8}$th of an inch broad, having a small oval ring near one extremity, for the purpose of holding it steady;—2d, a steel stilet (*b*), lancet-pointed at one end, and armed with a button, or circular disc, at the other; which is intended to pass through the canula, and to be projected beyond it, so as to penetrate the rectum, if the fistula has no internal opening; its dimensions are such that it fills the canula completely;—3d, a portion of a fine watch-spring (*c*), with a lenticular button at one extremity, sufficiently large to fill the canula, but small enough to glide through it with ease; and the other end furnished with an eye, and armed with a ligature, which Dr. GIBSON generally forms from a piece of French braid. The canula having been passed into the sinus to the desired depth, the puncture effected, if necessary, and the stilet withdrawn, the elastic needle or spring is introduced; its blunt end passes into the rectum, and immediately descends toward the anus, where it is easily caught by the finger. The whole length of the spring is now drawn through the anus, the ligature follows, it is then detached from the eye of the spring, the canula is removed, the dependent extremi-

ties of the braid are tied as usual, and the operation is complete. This mode of treatment is free from all the objections urged against the ancient plans of the probe and wire; it is simple, rapid, very easily performed, and frees the patient from the pain produced by the pressure of the latter instruments when the surgeon is endeavouring to bend them in the rectum. Preferring, as we do, the knife in every case of fistula not extending above the anal canal, and believing the extensive division of the septum in external incomplete fistula, to be seldom or never necessary, we should not often employ the stilet in the above described apparatus; but believing the ligature greatly preferable to the knife, for dividing the upper part of the septum in true stercoraceous fistula, we cannot but esteem the instrument of Dr. Gibson a very valuable addition to the apparatus chirurgica.

g. *Method by incision.* Having already enlarged upon the just value of the danger of hemorrhage as an objection to the use of the knife; and having also expressed our opinion as to the extent to which the division of the septum should be carried in cases of external incomplete fistula, it is only necessary to add a few words upon the plan formerly styled *the method by excision*, before we proceed to analyze the apparatus, and describe the operation of incision.

The plan of laying open the whole route of the sinus in fistula in ano by sharp instruments, is quite as ancient as either of the methods already noticed; for it is hinted at—though without sufficient details—in the Hippocratic treatise to which we have already referred. But the older authorities were constantly misled by the notion that the callosities and indurations consequent on the inflammation of any part, were malignant alterations of structure, requiring removal before a oure could be effected. Those, therefore, who did not accomplish this purpose by caustic applications, generally followed the advice of Albucasis, Jean de Vigo, Durand Sacchi, and Severinus, who employed the actual cautery after the operation; that of Guy de Chauliac, who made his incision by means of a red-hot bistoury introduced on a grooved sound; that of Celsus, who excised the interior parietes of the sinus; that of Leonidas, who carefully removed all the callosities by means of a forceps, a knife, and a peculiar speculum; or lastly, that of Dionis, who contented himself with scarifying the indurations after having laid open the sinus. All these modes of proceeding have been finally relinquished, except those of Celsus and Dionis, of which traces are still discoverable in the directions of Boyer and Roux for operating on deep-seated fistulæ; directions still advocated by many continental surgeons, and which appear to have received the sanction of Velpeau. (*Méd. Opérat.* III. 1024.)

At present, neither scarifications nor excision are at all recommended in England or this country, unless when the skin around the external orifice of the fistula has become so completely attenuated that, while it still retains its vitality, it is altogether incapable of effecting a union with the surface beneath;—a condition seldom observed except in persons of depraved constitution. The propriety of excising the flaps in such cases, need not be discussed in the present article. The same difficulty is often presented in cavernous ulcers of other parts, and in certain buboes. We will merely remark that the sensibility of the flaps in such cases, is almost destroyed, and hence, no operation upon them produces much pain, unless carried beyond the necessary limits. We have been convinced by numerous comparative observations that the application of caustic alkali is decidedly more beneficial than the knife, for their removal; for the more extensive and longer continued action required for the separation of the sloughs, increases the vital action of the surrounding parts, and promotes the rapid cicatrization of the surface.

The *earliest recorded instrument* for laying open the sinus of a fistula in ano, is the *syringotome* of Galen (*Meth. Med.* lib. vi. cap. 4.), a falciform knife, with a probe point, having its concave edge sharpened like a bistoury. It was used as a hook, and was passed through the outer and the inner orifice into the rectum, carried out through tne anus, and then being drawn downward, it divided the whole septum. If the fistula was incomplete, the rectum was first penetrated in some of the modes already noticed when speaking of the method by ligature, or the blunt point of the syringotome was made to penetrate the thin parietes of the canal, and the operation was then completed as before. This instrument underwent very numerous modifications in the hands of succeeding surgeons. Its extremity was generally attenuated and deprived of a cutting edge, for a sufficient distance, to allow it to pass through the sinus before it commenced the incision. This rounded extremity was afterwards replaced by a

flexible probe, soldered to the extremity of the knife. LEONIDAS, whose mode of operating was complex, and required the speculum, used an instrument resembling the curved bistoury with such a stilet attached (ANDREA A CRUCE. *Officin. Chirurg.* p. 43.), which is said to have been first made movable by means of a screw, by LEMAIRE of Strasbourg. (*Dict. des Sciences Médicales.* LIV. 163.) FELIX, DIONIS, and BASSIUS, employed instruments of very similar construction. (SPRENGEL. *Hist. de Med.* VII. 275.; HEISTER. *Inst. Chir.* Tab. 25.) Dr. RODGERS of New-York, has given to the knife of LEONIDAS the greatest degree of improvement of which it is susceptible, by appending the movable and flexible probe of LEMAIRE to a curved bistoury, nearly on the model of that used by Mr. POTT (*New-York Med. and Phys. Journ.*), a modification somewhat similar to that of LARREY, who uses the same kind of a stilet appended to a grooved director. (VELPEAU. *Méd. Opérat.* III. 1019.) PAULUS ÆGENITA reduced the operation almost to its present simplicity, by sometimes using a common bistoury, with which he divided the septum upon his finger introduced into the rectum; but he had a needless dread of wounding the sphincter muscles. (*De re medica.* lib. vi. cap. 78.) This mode, long neglected, was finally revived by Mr. POTT (*Chir. Works.* III. 71.), whose curved bistoury is still in use and takes place of most other instruments in American practice; though a sharp-pointed one is substituted when it becomes necessary to puncture the rectum or anus. A straight bistoury is preferred whenever its form is adapted to the direction of the sinus.

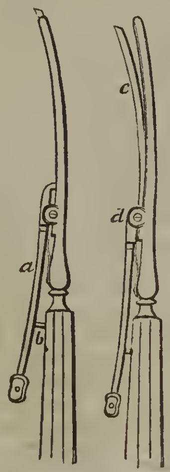
The *grooved sound*, as a director to the knife, in making the incisions, was introduced by J. L. PETIT, when he rejected the elongated beak of the syringotome, because he found its introduction painful and difficult. (*Traité de Mal. Chir.* II. 223.) It is generally made of flexible materials, so that it may be brought out at the anus when the internal orifice is not too deeply seated; and it still continues in very general use. In cases where the incision does not extend above the middle region of the anal canal, its application is not troublesome; but the bistoury of Dr. RODGERS is more simple, because it serves the double purpose of a director and a knife. When the internal orifice is more deeply seated, both these instruments are objectionable, because neither can be brought to the anus without very painful pressure upon the septum. If the director be employed, simply as a guide to carry the knife into the rectum, without reappearing at the anus, an assistant becomes necessary, because the surgeon has the index of one hand engaged in the anus, while the other hand is wholly occupied with the knife. In such cases, some modification of the guarded bistoury is greatly preferable.

The scissors, first brought into notice for the division of the septum in fistula in ano, by WISEMAN, were very justly condemned by PETIT; but they were employed by BOYER for removing flaps of denuded intestine, and are still in use among the advocates of excision.

Those who resort to incisions in very extensive fistula, are sometimes obliged to employ an instrument to receive the point of the director, or the bistoury, when it enters the rectum beyond the reach of the finger. For this purpose, MARCHETTIS contrived the *rectal gorget.* (SPRENGEL. *Op. Cit.* VI. 272.) This is nothing but an enlarged director, made of metal, or of wood, and sometimes having its groove partly interrupted by ridges, to give greater fixedness to the point of the instrument; for it has undergone many modifications, by BASSIUS, (HALLER. *Diss. Chir.* IV. 480.); RUNGIUS, (HEISTER. *Instit. Chir.* CLXVIII. cap. ix. tab. 25.); BENJAMIN PUGH (*Treat. on Midwifery.* p. 144.); and PERCY (*Journ. de Méd.* LXXII. 175.). It was employed by DE LANGE, SABATIER, and BOYER, but for different purposes. It is still used by ROUX. (VELPEAU. *Méd. Opérat.* III. 1024.) Having given decided preference to the ligature in dividing the intestinal portion of the septum, we shall offer no farther comment upon this instrument, except that when formed of wood, it is well adapted to the end in view. PERCY and SABATIER used it to facilitate the application of dressings.

There is one objection against all the knives yet mentioned; an objection not removed by the use of the grooved director, or the gorget. This is the pain occasioned to the patient by the action of the edge on the walls of the sinus, before the point has entered the rectum or anus; and to remove this, the various forms of the *guarded bistoury* have been contrived. The first appearance of the guarded bistoury, was in the reign of Louis XIV., who was operated upon by FELIX with an instrument hence called Bistourie Royale, which we have already described. The cutting edge of this instrument was covered with paper, until the stilet had passed entirely through the sinus, followed

by the sharp part of the blade: the paper was then withdrawn and the incision completed. So great was the reputation gained by this operation, that according to DIONIS, all the courtiers of France who were so fortunate as to have any complaint of the anus, pressed upon FELIX, to imitate the example of the monarch, and were sorely disappointed if the nature of their case did not call for surgical assistance. The royal disease became fashionable, a mark of *bon-ton*—as Mad. SÉVIGNÉ expresses it (*Lettres.* X. 176. Edit. 1823.), and this circumstance exerted a wide-spread and favourable influence on surgical practice for a considerable period; but the instrument has been long abandoned. SENFF of Berlin contrived a syringotome caché upon the model of the guarded hernial bistoury of GARENGEOT. This instrument we have never seen: it was strongly recommended by PLATNER (SPRENGEL. *Op. Cit.* VII. 276.), and many contrivances of the same character followed, but few of them have continued long in use, if we except, in this country, the well-known guarded bistoury of Dr. PHYSICK (DORSEY. *Elem. of Surg.* II. 162. pl. xxii.): the only objections urged against this last, arise from the too great acumination of the blade, and the slight difficulty sometimes experienced in detaching the little hood of the guard, which receives its point. The knives of CRUICKSHANK, SAVIGNY, and WHATELY, have been but seldom employed in America. The most perfect instrument of this class is, perhaps, that recently described by Dr. MUTTER of Philadelphia (*Amer. Journ. of Med. and Phys. Sciences.* XIV. 80.), and we have therefore given a representation of it as since modified and improved. It is founded on the principle of the *lythotome caché*, and consists of, 1st, a steel staff with a wooden handle, and provided with a tenant-joint (*d*), from which, to the extremity, it is grooved to a sufficient depth to conceal the blade of a bistoury;—2d, a steel blade (*c*) and handle (*a*) intended to be secured by a screw which passes through the joint (*d*). At the joint, the blade is furnished with a mortise, partly seen in the left-hand figure, which permits it to slide upon the screw, so as to cause the point to project a little beyond or to be retracted a little within the groove of the staff. The handle of the blade is furnished with a short steel pin (*b*), which, when the point is projected, rests on the handle of the staff, and prevents the cutting edge from leaving the groove, but which, when the point is fully retracted, is received into a hole in the handle of the staff, and the blade is then made to appear, as in the right-hand figure. This instrument is used as follows: The point being retracted and the blade concealed, the staff is introduced into the sinus, and the finger of the unoccupied hand, into the anus. The instrument is then employed as a sound. If the fistula is complete, it is passed through the internal orifice, and the handle of the blade being depressed, the incision is made with the finger in ano resting both on the point of the staff, and that of the knife. If the fistula is incomplete, the place for puncture is chosen, the point of the knife is thrust forward, and the rectum perforated; the point is then drawn back, the instrument passed through the orifice thus made, and the operation is completed as before.



There are many other instruments and modes of operating on record, but we have confined our attention to such as have exerted most influence upon the practice of the present day; and after the very great variety of plans already enumerated, it will be reasonably expected that we should give a summary of our own selection. In complete fistula in ano having its internal orifice below the margin of the internal sphincter, the knife should be employed invariably, and the incision should include both openings. When the internal orifice is in the superior portion of the anal canal, we equally prefer the knife. When it is still more deeply situated, we must decide according to the condition of the septum. If this is firm, thick, and indurated, the knife is still indicated, because the ligature acts very slowly and produces great irritation under such circumstances; but if the internal parietes are thin, which is almost always the case, the ligature is preferable, and we should wait until it has ulcerated nearly or quite to the edge of the mucous membrane, and then divide the remaining portion with the knife,—unless, on farther trial, the method pursued by Dr. B. H. COATES should hereafter claim a preference. When the orifice lies very high in the rectum, the intestine, or its mucous coat

only, are simply denuded; in these cases, incisions, if not very dangerous, are at least liable to occasion very troublesome hemorrhage, and sometimes render necessary the actual cautery; the ligature is here decidedly preferable, but the cases are very rare. We can see no reason why the ligature should be inapplicable, as most surgeons pretend, when there are several internal orifices; nor can we perceive any motive for avoiding its use, when the same fistula has several external outlets: these may be laid into one, by incisions, without disturbing the progress of the ligature. When there are many fistulæ coexisting in the same individual, the necessity of performing several operations at different times, for their relief, depends on the condition of the patient.

In external incomplete fistula, we should be content with puncturing the anus near the upper end of the anal canal, on a level with the upper surface of the external sphincter, and then proceeding as in complete fistula.

In incomplete internal fistula presenting below the fascia media, the sac should be punctured by a thumb lancet, or opened by cutting with a scalpel or bistoury, upon the bent probe of Dionis, introduced from the anus. We have never seen cases such as are mentioned by Velpeau, which, seated between the fasciæ, open internally without approaching the surface; but if the physiological views we have given (Vol. II. p. 139.) are correct, they would probably recover if the internal orifice were simply enlarged. If not, they must ultimately assume some other form, or prove beyond the aid of art.

With regard to the selection of instruments;—in the first-named class of cases, the straight or curved blunt bistoury, or either of the sharp bistouries with the grooved director, may be used almost indifferently; the knife of Rodgers is neater, because more simple, and that of Mutter is scarcely less applicable. In all deeper incisions, the latter-named instrument and the guarded bistoury of Dr. Physick enjoy the advantage in point of simplicity. In many cases, the knives in the ordinary surgical pocket-cases will answer the purpose, if the others are not at hand; but as they occasion unnecessary pain, they should be dispensed with, if possible. The danger to the finger of the surgeon in puncturing the rectum is much exaggerated—if the point of the knife is made nearly square, as it should be, and the precaution is used to complete the passage rather by cutting than by a thrust, the unavoidable incision of the finger is too slight to deserve notice.

The proper preparation for the operation by incision consists in lessening, if necessary, the irritation of the part, and in bringing the bowels into a regular condition. A mild laxative may be administered the day before, and an enema on the morning of the operation. Within an hour, an opiate should be administered, to lessen the sensibility of the part and to prevent discharges. The diet for some days before and after the incision, must be such as is calculated to lessen the bulk of fæces, that the patient may remain undisturbed as long as possible—but it should be rendered nutritious as soon as the patient's condition will permit, in order to hasten the cure.

There are several convenient attitudes for the patient, while undergoing the operation. He may be placed as directed in the section on fissure; he may lay prone upon the side of a bed or table, with the thighs dependent, which is the most common arrangement; or he may kneel upon a bed with his elbows and knees approximated. Two assistants should separate the nates, while a third, if necessary, attends to the instruments. The surgeon employs the index finger of one hand in the anus, while the other is engaged with the knife in the sinus. When the instrument has penetrated to the finger, both are withdrawn *pari passu*, in a direction as nearly parallel as possible, and thus the entire septum is divided with the least resistance.

When troublesome hemorrhage occurs, which is very rarely the case, the vessels, if seen, should be tied. If the incision has been very extensive, and the bleeding is internal, we can sometimes discover its seat by pressing the finger on various points in the wound, and it may then be arrested by ligature; but when this is impossible, we must introduce a plug into the anus, or resort to some of the measures laid down in the section on tumours. The pledgets of Petit and Boyer, of which the plan of Dr. J. R. Barton (see Vol. II. p. 115.) is a modification, are recommended by Velpeau. (*Méd. Opérat.* III. 995.)

The dressings required in this operation are very simple. The main object is to prevent union by the first intention, and for this purpose, as in most cases of a similar nature, the French stuff the wound with lint, and introduce a plug into the anus; while the English and American surgeons are contented with placing a

thin layer of lint between the edges, which should not be omitted for several days. M. Velpeau, however, in reply to a free stricture of Mr. Samuel Cooper, states that this difference of treatment is found more conspicuous in the books than it would be at the bed-side. Over the pledget, is laid, a piece of lint covered with simple cerate, then a compress of the same material, and others of muslin, if necessary, and the whole is gently supported by a double T bandage. The opiate may be repeated if an evacuation is dreaded at too early a period.

The operation by incision, in females, requires a short notice. M. Ribes remarks that there is more danger of injury from the knife when carried very high on the rectum in this sex, because the peritoneum is so differently arranged. The proximity of the vagina is also a cause of embarrassment when the sinus is anterior to the rectum, and it then gives rise, in some cases, to recto-vaginal fistula. Moreover, the fascia superficialis is more directly continuous with the fascia media, and hence abscesses of the vulva sometimes make their way to the anus, becoming complicated with true stercoraceous fistula, and requiring the complete incision of the whole route of the sinus. M. Velpeau also mentions an interesting case of this nature.

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Reynell Coates.

ANUS, ARTIFICIAL or PRETERNATURAL. *Anus contre nature, Anus anormal,* Fr. A permanent opening of the intestines communicating externally, either through the abdominal parietes or pelvic viscera. It may occur congenitally; or be accidental, resulting from disease or injury; and is sometimes formed by the surgeon, as the sole means of preserving the life of the patient.

Congenital artificial anus will be treated of in the articles on the vices of conformation, to which it owes its existence. (See *Rectum, Intestines,* &c.)

Accidental artificial anus will be considered with the diseases and injuries which produce it. (See *Hernia; Intestines, wounds and obstructions of,* &c.)

An *artificial anus* is formed by the surgeon, in cases only of congenital or accidental obliteration of the natural passage for the fæces, where it is impossible to restore this passage. The exposition of the methods of performing this operation, cannot be conveniently separated from the consideration of the disorders which require its performance; the whole will therefore be discussed in the appropriate articles. (See *Rectum, malformation of; Intestines, obstruction of,* &c.) I. H.

ANUS, IMPERFORATE. The term imperforate anus is applied to those malformations in which there is an obstruction to the discharge of fæces by the natural outlet. These vices of structure consist, 1st, in a contraction of the anus; 2d, the closure of this organ by a membrane; 3d, its complete obliteration or entire absence, no vestige of it existing, the intestinal tube terminating in a *cul-de-sac* in the rectum or some other portion of the canal, or having a preternatural opening. (See *Artificial anus.*)

We shall notice at present only the two first-named errors of structure, to which, indeed, the epithet imperforate anus is alone strictly applicable; the last will be considered in the article *Rectum,* to which we must also refer for the anatomical history of these vices of formation, as well as for various other details here omitted in order to avoid repetition hereafter.

The existence of imperforate anus, if overlooked at the moment of birth, soon makes itself known by a train of morbid phenomena resulting from the retention of the meconium. After some hours, from ten to twenty, have elapsed without an alvine discharge, the little patient becomes restless, cries plaintively, the diaphragm and abdominal muscles are excited to violent expulsive efforts during which the respiration is sometimes suspended, the face becomes red, and the abdomen hard. These symptoms gradually augment in violence, are of longer continuance, and

appear at shorter intervals. If no relief be afforded, the tenseness of the abdomen increases, especially at its lower part, which becomes hot, and painful on pressure. Soon, the liquids swallowed, afterwards the mucous and biliary secretions, and finally, matters analogous to meconium, are ejected by vomiting. Things continuing in this state, death is inevitable, and takes place from the third to the eighth day, according to the vigour of the patient.

When the first twenty-four hours after birth elapse without an alvine discharge, and some of the preceding symptoms manifest themselves, the anus and rectum should be attentively and thoroughly explored, so as to determine accurately the precise seat of the atresia, if it exist, and the character of the malformation. If the obstruction be in the anus, it will be found to consist either in an extreme contraction of this organ, so that it will scarcely admit the finest probe, or its closure by a membrane.

Extreme congenital contraction of the anus must be remedied by an incision made in the direction of the os coccygis, with a probe-pointed bistoury; and the opening thus made gradually dilated by the introduction of a tent well anointed with simple cerate.

When the anus is closed by a membranous diaphragm, this partition will be usually found protruded by the fæcal matters, forming a roundish prominence having a doughy feel, and generally of a purple or livid hue. This tumour increases whenever the efforts to expel the fæces are renewed. At the moment when the infant strains and this membrane is most tense, a crucial incision should be made through it with a straight bistoury, which immediately affords a passage to the fæces, and with their evacuation all the distressing symptoms generally cease. It has been recommended to cut off the angles of the membrane formed by the incision, but this seems wholly unnecessary, as they soon retract towards their base and become confounded with the margin of the anus.

For Bibliography, see *Rectum*.

I. Hays.

ANXIETY, Αλυσμος, Gr.; *Anxietas*, Lat.; *Anxiété*, Fr. Restlessness; state of general malaise, difficult to describe, in which the patient complains of suffering without being able to locate his pains in any particular part of his body; attended with a perpetual inclination to change position. Inquietude is a less and anguish an exalted degree of this same condition Anxiety has been ascribed to some impediment to the passage of blood through the heart, or lungs or vena porta, but the mechanism of its production is not well understood. It is usually a very unfavourable symptom.

The terms *precordial*, *pulmonary*, and *epigastric anxiety*, have been given to a painful feeling or sense of constriction, referred by patients to these regions.

I. H.

AORTA. (Derived, according to some lexicographers, from αοςτεομαι, I am suspended; and by others, from αηρ, air, and τηρεω, I keep.) The great artery which arises from the left ventricle. Its situation, course, and relations, will be described under the head *Arteries*, where everything of importance, pertaining to its healthy condition, will be found. The principal anomalies of its origin and distribution, and of the branches which proceed from it, will be also noted under the same head.

It will only be necessary, in this article, to consider the modifications which take place in its form, volume, texture, and physiological actions.

§ 1. *Inflammation of the Aorta.* (*Aortitis.*) The coats of the aorta, in common with other tissues of the body, are liable to acute and chronic inflammation. The former, though much rarer than the latter, probably occurs more frequently than is generally suspected. Incidentally noticed by Aretæus and some of his successors, acute aortitis did not attract much attention, until J. P. Frank pointed out its intimate relations with the disease usually denominated inflammatory fever. Since then, it has been particularly described by Spangenberg, Joseph Frank, Hodgson, Kreysig, Bertin and Bouillaud, Hope, Naumann, and others. Its pathological characters are, however, still involved in considerable obscurity, and its distinctive symptoms are far from being certainly ascertained. We shall attempt to furnish a brief exposition of those anatomical characters which have been usually considered as consequences of inflammation of the aorta, either acute or chronic, with such a description of the symptoms, diagnosis, and treatment of the disease, as can be drawn from our present knowledge on the subject. A minute description, however, of the several lesions of the vessel would be incompatible with our arrangement, as it will be necessary to discuss the subject more in detail, under the head of *Arteries*, to which the reader may refer for that

additional information which may be necessary. We shall first describe an appearance which has been often mistaken for inflammation of the aorta.

Cadaveric coloration of the lining membrane of the aorta. This character, which has been so generally regarded as an indication of inflammation, has been shown by the investigations of modern pathologists, to furnish in itself no positive evidence of that condition. It is often associated with inflammation of the aorta, yet more frequently exists as a mere cadaveric phenomenon, where no evidences of disease can be discovered in the coats of the vessel. It is now ascertained, that the lining membrane of the artery often exhibits deep red, violet, or brown patches, striæ and bands, where no appreciable lesion of texture can be discovered, and that they are merely a consequence of a species of coloration of the tissue, arising from imbibition of the colouring matter of the blood, taking place either after death, or a short time previous to that event. This opinion, which was ably supported by Laennec and Hodgson, has been subsequently corroborated by numerous experiments and observations. The redness varies much in the intensity and other characters of its shades. It likewise differs greatly in its extent. Most generally it is disposed in patches, which appear as though a smooth coating had been laid upon the lining membrane of the artery with a brush. Occasionally, however, it has been found occupying the whole vascular system—both arteries and veins. The spots are sometimes rounded—sometimes disposed in bands or streaks parallel with each other, between which the membrane presents its natural pale colour. When the colour is thus limited, it is oftener found upon the posterior, than upon any other part of the aorta. Sometimes the redness is diffused, and occupies the entire circumference of the vessel, and is either a deep scarlet, cherry red, violet, livid, or even brown. Occasionally it is associated with a tinge of yellow, which impresses upon the tissue an *ecchymosed* appearance. The redness generally terminates abruptly, and does not lose itself by insensible shades in the neighbouring parts, like the redness which attends inflammation; neither is it, like that species of colour, associated with any arborescent injection of the vasa vasorum, or any appreciable pathological condition. It seldom extends to the fibrous tunic of the artery, though that tissue is sometimes found more or less tinged. Its intensity is increased by exposure to the atmosphere, and by the changes which take place in the chemical constitution of the solids and fluids after death. Washing often removes it so completely, that the natural pale colour of the tissue is restored; but in some instances it becomes so firmly set by the inception of putrefaction, that washing, and even maceration, exercise but little influence upon it.

The following facts furnish additional evidence of the non-inflammatory nature of this species of redness. It occurs more frequently in warm than in cold weather, when of course the rapid progress of putrefaction, and the influence of heat upon the tissues, render them more liable to have incorporated with them the colouring matter of the blood by the processes of imbibition or transudation. It is greater when considerable time has elapsed before the body is opened; increases as the putrefactive process advances, and is oftenest met with in the bodies of those who have died of diseases attended with a dissolved state of the blood, and a general diminution of the cohesiveness of the tissues. Dalmas remarks, that having had occasion, in the years 1824, 1825, and 1826, to open a great number of bodies, he observed the appearance in question much oftener in July and August than in winter, and that it was most common in those who had died in the surgical wards, from protracted suppuration and ataxic fevers. (*Dict. de Méd.* 2d edit. III. 392.) In the experiments of Rigot and Trousseau, the same species of redness was produced by confining the blood within a portion of the artery, and they ascertained that it was always greatest in those cases in which the blood was black, dissolved, and contained but little serum;—as in those who had died of typhoid and ataxic fevers, or other similar diseases. Blood of this kind was found to produce the tinge when applied to a healthy vessel, and in horses in which it existed, the arteries of the extremities were not red, when the body was placed upon the back, so as to leave the limbs elevated. (*Archiv. Générales.* XII. 119. 333., XIII. 461., XIV. 321.)

The redness has besides been observed in some epidemics and not in others. Tanchou and Rayer often met with it in small-pox; and in an epizooty which prevailed amongst horses with great fatality, in 1825, Dupuy, Andral, Girard, and Bouley, found the lining membrane of the arteries presenting this peculiar redness in a majority of cases, even when the examination was made half an hour after death; although Rigot and Trousseau,

who made their investigations in the following year, upon horses dead of the same disease, did not meet with this condition of the blood-vessels. (Andral. *Prècis d'Anat. Pathologique.* II. 351.) We may subjoin, that the same appearance of the lining membrane of the aorta was observed by Jaehnichen and Markus, Otto, Pfeiffer, and Gescheidt, in some of the bodies of those who died of cholera, especially when the examination did not take place until some time after death. (*Phœbus ueber den Leichenbefund bei den Orient. Cholera.* 53. Berlin, 1833.) In this disease, death takes place so speedily, that little suspicion can be entertained of the development of inflammation of the aorta. Redness of the lining membrane of the vascular system is very often observed in the bodies of those who die of *purpura* hemorrhagica, in which, softness and laxity of tissue, together with a dissolved state of the blood exist, which facilitate imbibition or transudation. Under such circumstances, these acts seem to take place to a certain extent even during life, and if the natural porosity of the tissues be considered, it can be readily conceived how it may occur after death, and that too with extreme promptitude, as in the cases reported by Andral, who discovered it when the examination was made within half an hour after the animals had expired.

Inflammatory redness of the lining membrane of the aorta. Acute inflammation of the aorta is nevertheless often associated with more or less redness of the lining membrane of the vessel. Its character, however, is different. It is less intense; less diffused, and not so abrupt in its termination in the neighbouring parts, but loses itself by insensible shades. It is not limited to the lining membrane of the artery, but extends to the fibrous and cellular tunics, and is besides associated with injection of the vasa vasorum of the two last tissues. Another important distinguishing mark is, the association of this species of redness with a manifest alteration of texture or secretion, which leaves no doubt of the existence of inflammation. Injection of the vasa vasorum must not always be looked for in acute aortitis; for although Hodgson and others speak of it as a common anatomical character of the disease, Bouillaud remarks, that he had only observed it in one instance out of a great number, and in that it was limited to a small space, and had the appearance of being connected with an accidental formation. (*Dict. de Méd. et Chir. Prat.* III. 194.) When this injection exists, it is most conspicuous in the cellular coat, if the inflammation affect all the tunics of the artery. It is not so evident in the fibrous coat; but a delicate plexus of minute vessels is sometimes observed, occupying the space between this tunic and the lining membrane.

Redness of the lining membrane does not exist in chronic aortitis. That tissue is, on the contrary, of a dull yellow, grayish, or of a green appearance,—much variegated, however, by the diversified shades exhibited in the several textural alterations which exist in the coats of the vessel.

Alterations of texture and secretion furnish much more unequivocal evidences of the existence of inflammation in the arterial tunics, than simple redness. Hence, Laennec, Mondovi, and nearly all the most modern pathologists, only consider that redness inflammatory, which is either associated with some sensible structural modification of the tissues of the vessel, or the deposition of lymph or pus within the cavity of the artery, or in the substance of its tunics.

Softening of the coats of the artery is an early effect of inflammation. The lining membrane becomes soft and spongy, and loses its natural polished appearance. Portal describes the case of a youth, who died in consequence of the repulsion of an exanthematous eruption, in whose body he found the internal membrane of the aorta red, tumid, and preternaturally soft. (*Anat. Médicale*, III. 127.) It can generally be detached from the fibrous tunic with great facility; and in some instances presents a slight villous appearance, similar to that exhibited by inflamed serous membranes. The fibrous coat becomes remarkably fragile, and is partially or completely divested of its elasticity. Softening likewise takes place to a limited extent in the cellular coat, which, at the same time, loses its natural pliability, but still remains somewhat resistant. It is, nevertheless, more yielding in this state than in its healthy condition; and this cause, co-operating with the diminished cohesiveness of the other tunics, is doubtless instrumental in giving rise to the preternatural dilatations of the aorta which are so often observed. There is likewise great fragility of the coats of the aorta, when they are affected with chronic inflammation. Although more dense than in their natural state, they are so inordinately brittle, especially the middle coat, as to be easily lacerated.

Induration is not often observed as an immediate consequence of acute aortitis: the chronic form of the disease, however, is very generally attended with this pathological state of the tunics of the artery. Still, the fibrous coat, though thinner and more rigid than in health, is preternaturally brittle, while the cellular coat loses its filamentous texture, becomes denser and more resistant, and frequently undergoes important changes in its nutrition, by which various new products are developed, of which we shall speak under a separate head.

With either softening or induration there may be associated increased thickness of the coats of the vessel, constituting a species of *hypertrophy;* or they may be more or less attenuated, or *atrophied.* These several pathological states may be confined either to a small portion of the aorta, or they may implicate the vessel to a great extent; and, very often, two or more of them are found associated,—different portions of the vessel being affected dissimilarly.

Ulceration of the aorta is very commonly a consequence of chronic aortitis; but the acute form of the disease probably seldom gives rise to it. The ulcerative process often occasions superficial erosions, which are confined to the lining membrane, and give it a rough appearance. In a number of instances, ulcers, variable as to their depth and extent, are formed, which terminate by well-defined borders. Some of them are not larger than a pin's head, while others are half an inch or more in extent. In those which are most superficial, the base is formed by the fibrous coat of the vessel; but sometimes this tunic is also destroyed, and the cellular alone prevents the blood from escaping. The bottom of the ulcer is rough, and is either covered by a small layer of coagulum, or a kind of darkish-coloured pellicle, which adheres to its surface. When the two inner coats of the artery are destroyed by an ulcer, the external generally becomes dilated at the point affected, and aneurism is induced; or it is destroyed in its turn, and a complete perforation and sudden death are the consequences. As regards the number and extent of the ulcers, much will depend upon the extent of the vessel that is inflamed. In some instances, there may be a single one, or only a small number, sparsely arranged. Yet cases sometimes occur, in which they are exceedingly numerous, and occupy nearly the whole length of the aorta. A case of this kind has been reported by Meckel, (Grandfather,) in which the aorta, from a small distance above the semilunar valves, to the iliacs, was most extensively ulcerated, and its internal coat, which exhibited a lacerated appearance, was detached at several points, and floated within the vessel. (*Mem. de l'Acad. des Sc. de Berlin.* XII. 1756. *Dict. de Méd.*) Andral likewise remarks, that he witnessed a case in which the internal surface of the whole extent of the thoracic and abdominal aorta was occupied by numerous small rounded ulcers, the medium size of which, was that of a five-cent piece. They were so superficial as to be with difficulty perceived, and the borders of some of them were surrounded by a brownish rose-coloured circle. There was no ossification of the coats of the artery. (*Précis d'Anat. Path.* II. 358.) We have often observed ulcers of variable size in different portions of the aorta, and in some instances, the lining membrane of the vessel has been detached in the vicinity of the ulcer to some extent, so as to suffer the blood to become slightly insinuated beneath it.

Ulceration of the aorta may take place in the same manner as in other tissues. In most cases, however, the manner in which it is induced is somewhat different. The ossific or calcareous plates, which so frequently form beneath the lining membrane, often detach it from the fibrous coat, and finally lacerate it, or project through it, so as to be placed in immediate contact with the blood. These scales are occasionally detached in this manner, and the bed they previously occupied is transformed into an ulcer. In other cases, the small atheromatous, tuberculous, and other deposits, which so often form between the internal and middle coats of the artery, give rise to a destruction of the former, and become converted into small ulcers. It is probably in this way that a large majority of them have their origin, though it should be remarked, that they may also proceed from the rupture of small abscesses.

Ulceration of the aorta may, besides, take place externally, and advance inwards. When this is the case, the ulcerative process originates in some disease situated in the vicinity of the vessel, and gradually exercises its ravages, so far as the latter is concerned, first upon the cellular coat, and subsequently upon those which are deeper seated. We shall have occasion to speak of a rare form of aneurism, which is sometimes induced in this way; but a much more frequent conse-

quence of this excentric ulceration, is the development of perforations, sometimes establishing communications between the aorta and the trachea, bronchi, œsophagus, lungs, &c. (See § 4, and § 7.) It is not easy to determine whether ulcers of the aorta cicatrize, like those affecting other tissues. Bouillaud seems inclined to think they are capable of undergoing this change. Hence he infers, that the small puckered depressions which are sometimes observed occupying the internal surface of the vessel, in connexion with other symptoms of chronic aortitis, are cicatrices, indicating the site of ulcers which have healed.

The *effusion of plastic lymph* within the vessel, or in the substance of its tunics, and the formation of pseudo-membranous deposits upon the surface of the lining membrane, are characters of aortitis that cannot be mistaken, when they occur. These deposits would be oftener met with, were it not that the lymph is borne along by the stream of blood as soon as it is poured out, and is thus prevented from accumulating and adhering to the lining membrane. Sometimes the lymph is deposited in small quantity, and merely adheres to the coat of the artery in form of a soft gelatinous pulp, (*mollis succus pultaceus*, Haller,) which can be wiped off with very slight force. In other cases, it forms shreds, flocculi, bands, or even a continuous membrane, of considerable extent and thickness, which adheres closely to the original tissue. These pseudo-membranes may occupy the vessel to the extent of several inches, or be confined to one or more small points: they also form, occasionally, masses of so large a size, as to encroach considerably upon the caliber of the artery, and impede the transmission of the blood through it. Examples of the arrangement last described, have been noticed by Boerhaave, De Haen, Spangenberg, Burns, Bertin and Bouillaud, &c.; and others will be found reported in the *Eph. Nat. Curios.* Dec. I. obs. 18. Dec. III. 85. *Act. Nat. Curios.* X. obs. 95. *Nov. Act. N. Curios.* VII. obs. 37. Morgagni, *Epist.* XXXVIII. 40. Klauning, *Nosoc. Charitat. Hist.* 4. and 22. Patin, *Epist. de Aorta polypose*, 1731; and Joseph Frank, *Praxeos Medicâ Precept.* II. part 2. 300. Other examples will be referred to, when we treat of obstruction and obliteration of the aorta. Cases in which the adventitious lymph deposits were less considerable, and presented the characters first described, have been noticed by Haller, J. P. Frank, Bertin and Bouillaud, Spangenberg, Mondovi, Burns, Farre, Kreysig, Hodgson, Gendrin, Barde, Hope, S. Jackson, and many others, whose names it is unnecessary to enumerate.

Suppuration is probably a rare attendant or consequence of inflammation of the aorta, as it has not been often observed. Well authenticated cases have, nevertheless, been reported, from which it appears, that the matter may be poured out from the arterial tunics, either with or without abrasion, or be collected into small abscesses, which occupy the space between them. Monro has made some remarks (*Edinburgh Med. Essays*, Vol. II.) on the formation of purulent matter by the internal surface of the arteries; and Welch has described the case of a female, who died suddenly, under the influence of a fit of anger, in whose body he found two abscesses occupying the aorta, in the vicinity of the heart, through which the blood had been extravasated, so as to occasion her death. (Lieutaud, *Hist. Anat. Med.* Lib. II. obs. 667.) Storck found the aorta, to the extent of an inch from its origin, as well as the heart itself, in a state of suppuration. (Ibid. obs. 517.) Weitbricht has also described a case in which the vessel at its origin was in the same state. (*Comment. Petrop.* IV. 263.) The most satisfactory case, however, is one reported by Andral. The lining membrane was elevated at different points, by half a dozen small abscesses of the volume of a small nut, which were situated between the serous and fibrous coats of the vessel. The matter they contained resembled the pus of an ordinary phlegmonous abscess. (*Op. Cit.* II. 379.) Lobstein also reports a case, in which he observed small cavities of a yellowish straw-colour, occupying the internal surface of an aorta which was affected with aneurism. When opened, they discharged a few drops of pus, of the colour and consistence of thin cream. (*Traité de Anat. Path.* II. 544.) Allusion is made to a similar condition, by Hodgson. Such collections naturally tend to destroy the thin lining membrane which is interposed between them and the blood, and thus escape into the artery. When this event takes place, the remaining cavity is apt to be converted into an ulcer, as we have already explained.

Atheromatous secretions are of more frequent occurrence. The most simple form in which they appear, is that of small yellowish points, which elevate the lining membrane, and project into the cavity of the vessel, like minute pustules. These elevations consist of small collections of a

peculiar matter, exceedingly variable in its consistence; being in some cases perfectly fluid and resembling thin pap, but occasionally of a thicker consistence, and somewhat curdy, or like the matter which is discharged from a scrofulous abscess. Such collections are formed at first, between the internal and middle coat of the artery, but as they increase in size, they impair the structure of both, finally destroy the former, and become converted into small ulcers of the character we have already described. The precise nature of these secretions, which are so often met with in the tunics of the artery, has not been satisfactorily ascertained. By some, the matter denominated atheroma, has been considered merely as a modification of tuberculous secretion, and several pathologists regard both as the inceptive stage of the calcareous transformation. In corroboration of this view, they affirm that these deposits seldom exist to a great extent, without being associated with more or less ossification of the coats of the vessel. Be this as it may, they often lay the foundation of aneurism, by gradually destroying the serous and fibrous coats of the artery, merely leaving the cellular or external to sustain the onus of the circulation. Their importance in this respect, was clearly pointed out by Scarpa, and has been fully acknowledged since his time. (See *Aneurism.*)

Tumours. Adventitious developments, in form of irregular masses of variable magnitude and consistence, have been described as occasionally occupying the coats of the aorta. By some of the earlier writers, they were denominated polypus, and in more modern times, some of them have been described under the appellation of steatomatous tumours. Examples of this kind have been already referred to, especially the cases reported by De Haen, Patin, and in various parts of the Ephermeredes. Stenzel has particularly described a similar tumour of the arch of the aorta, which was white and compact externally, and contained within, a firm sebaceous and adipose substance. (*Dissert. de Steatom. Aortæ.* 1723. Guthrie, p. 34.) The aorta was so much distended by the tumour, as to nearly equal the heart in volume, and its caliber was so greatly diminished, that the blood could with difficulty pass through the vessel. A case has likewise been reported by Pietro Paulo dell'Arme, in which a tumour was found near the orifice of the aorta, which had its origin between the tunics of the artery, and completely filled up its cavity. When cut open, a quantity of purulent matter escaped, equal to several small spoonfuls. (*Saggi, di Med. Practica, con note di Borsieri*, Obs. 35. Faenza, 1768. Frank, 302.) We may also refer to two cases observed by Corvisart, which possess considerable analogy with some of those to which allusion has been made. In one of these, a tumour as large as a walnut, and of a firm consistence, adhered to the arch of the aorta. It was surrounded by a firm fibrous membrane of two lines in thickness, which included a substance of a red colour, not quite so consistent as tallow. No communication could be discovered between the interior of the tumour and the cavity of the vessel,—the outer coat of the latter being destroyed, while the others were only a little attenuated. A similar tumour, somewhat smaller, was discovered a little above the cœliac artery. In another case, he saw two or three tumours of the same kind adhering to the ventral aorta. (*Essay on the organic diseases of the heart and great vessels.* p. 242. Am. edit. Philada. 1812.) Since that period, similar tumours have been several times noticed by different individuals, and especially by Hodgson and Guthrie. The former, however, thinks they are merely aortal aneurisms which have become spontaneously cured; and in this sentiment he is followed by a majority of the most recent writers. Guthrie, nevertheless, while he admits that this may be the case, seems inclined to concur with Corvisart, in regarding them as of a different nature. Whatever view be adopted in reference to these particular cases, it is certainly true, that small vegetations and tumours do sometimes spring from the coats of the aorta, and project into its cavity. They seldom, however, present a proper steatomatous character, but vary so much in their structure, that it is not easy to apply to them, collectively, any appellation calculated to convey a clear idea of their nature.

Cartilaginous and *osseous*, or rather *calcareous*, transformations, are the most common morbid changes to which the tissues composing the aorta are liable. The extent to which they exist is exceedingly variable. Sometimes merely consisting of a few minute isolated points of a yellowish colour, they frequently form large plates or scales, embedded between the serous and fibrous coats of the artery, and occasionally converting the whole circumference of the vessel into a rigid cartilaginous, or calcareous cylinder. Very frequently the earthy scales destroy the

lining membrane, and have one of their margins projecting into the artery; and sometimes they become completely detached, as has been previously remarked. Cartilaginous plates often alternate with such as are of an earthy character, and the whole inner surface of the affected portion of the vessel presents an uneven rugged appearance, the lining membrane being either destroyed at points, exhibiting numerous cracks or fissures, or materially altered in its properties. These lesions, however, are so common throughout the whole arterial system, that they can be better described under the head *Arteries*, and need not be particularly considered in this place. It may, nevertheless, be proper to remark, that the term ossification, which has been generally employed to express the manner in which they are formed, is not appropriate, as the calcareous crusts are rather the result of a species of crystallization of the earthy matter poured out by the diseased vessels, than of a process analogous to that by which bone is formed. When these transformations exist even to a limited extent, the elasticity of the vessel is greatly impaired, and when they are extensive, it is completely destroyed, while the tunics themselves become so friable and brittle, that they yield under the application of very slight force. The calcareous transformations sometimes attain a very great size, and either exist in form of broad flattened plates, or of thick, rugged, uneven masses. Tulpius reports a case, in which he found a fragment of this kind occupying the aorta, which weighed two drachms (*Obs. Med.* Lib. II. cap. xxv. p. 134. tab. vi.); and examples are not wanting, in which the coats of the vessel have become so loaded with this species of morbid crystallization, as to be converted into firm unyielding cylinders, remaining perfectly passive as regards the circulation of the blood. In all cases, they have their origin in the very delicate cellular or filamentous tissue which serves as the bond of union between the internal and middle coats of the aorta, and not in the lining membrane as was formerly supposed. The question relative to their dependence upon chronic inflammation, is a point which will be discussed under the head *Arteries*.

Cancerous or encephaloid degeneration of the aorta is probably of rare occurrence. Laennec, nevertheless, remarks, that he has occasionally discovered small particles of this morbid product deposited in the cellular coat of the aorta. (*Auscultation Médiate*. II. 684.)

It may be supposed by some, that there is no valid reason for treating of all these lesions under the head of inflammation of the aorta. It is possible that some of them may arise from other causes. Yet as in the present state of our pathological knowledge, this question cannot be decided, we have thought it better to group them all under one head, than to make a multiplicity of divisions of the subject.

Symptoms and Diagnosis. There is perhaps no disease, the symptoms and diagnosis of which are more difficult and uncertain, than those of aortitis. The deed situation of the vessel, its intimate and ex tensive relations with so many organs, and the extreme difficulty there is in distinguishing those phenomena produced by the action of the aorta, from such as are attributable to derangements of the heart's action, render it almost impossible to determine with certainty the existence of this disease, or to discriminate between it and other affections. Joseph Frank, who has witnessed the disease in its acute form, and who has furnished a very good digest of the observations made by others relative to its phenomena, has given a full enumeration of the different symptoms which have been witnessed during its progress. They are "increased heat and redness, with great itching of the skin; pain of the head and extremities; flushing of the face; ringing of the ears; increased brilliancy of the eyes, with rolling of the balls; epistaxis; dryness of the mouth and tongue, with urgent thirst; difficulty of deglutition; a sense of heat beneath the sternum, or above its triangular notch; a feeling of burning, like that occasioned by a hot iron, extending along the whole tract of the aorta, even down to the iliacs; vertigo and clouded vision, or objects appearing of a green colour; a disposition to syncope from slight exertion, or when the body is in the erect posture; a vibratory pulsation of the carotids, and of the arteries of the whole system; the pulse frequent, sometimes intermittent, hard and chorded, imparting the sensation of a metallic wire beneath the finger; turgescence of the superficial veins; oppressed breathing; jactitation, and great anxiety; the urine scanty, scalding, very high coloured, depositing a copious sediment, and sometimes purulent; palpitation of the heart, cough, vomiting, diarrhœa, and subsultus tendinum. The disease either continues in its course, or exacerbating, is generally protracted to the seventh day, when it terminates in health or becomes chronic; or death

ensues. The crisis generally takes place by a free perspiration; but when the malady assumes a fatal turn, the extremities become cold, while the internal parts are affected with the sensation of a consuming heat; the pulse fails, and death ensues." (*Praxeos Medicæ Univers. Precept.* II. pars. 2. p. 297. Lips. 1824.)

A glance at these symptoms will show how inadequate they are to distinguish the disease. There is not one of them that is not common to many other affections; and several of them would apply as well to any other disease, as to inflammation of the aorta. J. P. Frank thought the peculiar hard, tense, and chorded pulse characterized the disease with more certainty than any other symptom; but we are disposed to concur with Bouillaud, in regarding an augmented activity of the pulsations of the aorta, a sense of heat and uneasiness in the course of that vessel, a feeling of great anxiety, and a disposition to syncope such as occurs in many affections of the heart, more entitled to confidence. (*Dict. de Méd. et de Chir. Prat.* III. 179.) But even these symptoms are observed in acute pericarditis and some other diseases of the organs of circulation, and cannot justify a positive conclusion. The stethoscope will generally enable us to distinguish the pulsations which attend this disease, from those occasioned by an aneurism, and a careful examination of the abdominal aorta will sometimes facilitate the formation of a correct diagnosis. It must not be forgotten, however, that effusions of water in the cavity of the thorax and abdomen, the development of tumours in the course of the aorta, the distension of the intestines with gas, &c., will tend to render the pulsations of the vessel more perceptible than they would be under other circumstances. Should, however, all these conditions be absent, while there are violent pulsations, and a sense of heat in the course of the vessel; throbbings of the arteries generally; turgescence of the veins; redness and heat of the skin, and general uneasiness, with a liability to syncope on the slightest exertion, we may reasonably suspect the existence of acute aortal inflammation, especially if pericarditis, aneurism, or hypertrophy of the left ventricle of the heart be not indicated by the ordinary physical and rational signs. J. P Frank supposed that acute arterial inflammation was the essential pathological condition of the common inflammatory fever:—an opinion which many have adopted since his time. We shall not discuss the validity of this hypothesis in the present place, as it can be more appropriately considered under the head of *pathology of the arteries.*

The symptoms of chronic aortitis are still more equivocal. The disease seldom creates so much disturbance as to awaken a suspicion of its existence, until it has made considerable progress, and even then its principal symptoms, according to Bouillaud, are merely such as result from a mechanical obstacle to the free transmission of the blood. The individual frequently experiences a difficulty of respiration, or exhaustion, on taking the slightest exercise; the countenance is pale and sallow; the blood accumulates in the left ventricle, and excites frequent palpitations; the cavities of the heart become dilated or hypertrophied, and serous effusions finally take place. (Bouillaud. *Loc. Cit.*) If these symptoms exist when there are no evidences of disease at the orifices of the heart, or none of aneurism of the aorta, there will be reason to fear the existence of important alterations of the structures which compose that vessel.

Causes. The causes of inflammation of the aorta may be divided into traumatic, as injuries of various kinds, and such as give rise to inflammation of other internal organs. It may be excited by violent passions of the mind; preternatural exercise too long continued; the excessive use of acid or stimulating drinks; the operation of cold upon the surface of the body, &c. In one of the cases reported by J. P. Frank, the disease was brought on by the violent exercise which the individual was forced to take, in attempting to fly from justice, for the crime of homicide; and Joseph Frank met with a case in which it was excited by taking a copious draught of vinegar by mistake, instead of water. The disease is probably often induced by the imprudent use of mercury; and there are certain affections of the system, as gout, scrofula, scorbutis, syphilis, &c., which have a great tendency to excite chronic inflammation of the aorta. (Kreysig. *Krankheiten des Herzens. Theil.* II. 747. Hodgson. *Loc. Cit.*)

Treatment. As little is known, unfortunately, of the treatment of aortitis, as of its symptoms and diagnosis. In the acute form of the disease, general principles indicate the necessity of free abstraction of blood, both by the lancet, and by leeches applied along the course of the aorta. This practice is imperatively demanded, whenever the momentum of the aortal circulation is greatly increased, and

it must be repeated as often as necessity may demand, care being always taken to regulate the quantity by the capability of the system to endure it. It should nevertheless be borne in mind, that inflammation of the aorta, and of the arterial system generally, sometimes takes place in the course of fevers of a malignant or ataxic character. Under such circumstances, the abstraction of blood can seldom be resorted to. The patient should be confined to a strict antiphlogistic regimen;—be allowed bland, cooling, and refreshing drinks, mild saline aperients, and in short, all the usual means for diminishing preternatural activity of the heart and arteries. In addition to depletion, it may be useful to administer digitalis in such a manner as to obtain its influence upon the circulation. The system may be kept under its control for some time, care being taken not to push the dose too far. Prussic acid in small doses repeated according to circumstances, may likewise prove beneficial, when the inflammation is associated with preternatural nervous erethism, characterized by a peculiar irritable thrill of the pulse, and that state of the nervous system which exists under such circumstances. Paginini speaks favourably of a bath, containing four ounces of aqua Amygdalæ amaræ, or aqua Lauro-cerasi,—the strength to be gradually increased; also of baths of aconitum, cicuta, hyoscyamus, &c. (*Annali Universali di Med.* 1826.) They are only applicable to the chronic forms of the disease; and under the same circumstances, alkaline baths, containing opium in solution, have been recommended. (Naumann. *Handbuch der Medicinischen Klinik.* II. 775. Berlin, 1830.) Great care must be taken not to resort to active revulsives too early, lest by increasing the excitement of the system, they should augment the local affection. When they are proper even, blisters will often be found too stimulating and must be resorted to with caution. Generally, pustulation with tartar emetic ointment will deserve the preference. Every source of excitement must be most scrupulously avoided, and this will be not less important as regards those of a mental character, than such as act through different channels.

Chronic aortitis being infinitely variable in its general symptoms, and the character of the organic lesions it occasions, must be treated upon general principles. When congestions take place in the left ventricle of the heart, giving rise to palpitations and other disturbances of circulation, small abstractions of blood must be made, either by the lancet, or an adequate number of leeches. Repose of both mind and body should be enjoined, and every source of irritation carefully avoided. When the disease has continued for a long time, and is attended with a general impairment of the nutritive energies, a different treatment may become necessary. Under such circumstances, it may be useful to put the patient upon a course of chalybeate remedies,—in mild weather, the cold shower-bath,—and to recommend the employment of some appropriate mineral waters. It must not be concealed, however, that all treatment in such cases must be merely palliative, and can effect little more than a temporary mitigation of immediate symptoms, or prevent the development of those consequences, to which the disease is so apt to give rise.

Aortitis which takes place as a complication of other diseases, must be treated on general principles. When it arises from syphilis, it has been supposed by some that mercury will be the most appropriate remedy. It should be remembered, however, that the disease is often excited by that article, and may be aggravated by its influence.

Of erysipelatous inflammation of the aorta we shall not speak, farther than to remark, that it may sometimes exist. We know nothing of its proper symptoms, and cannot distinguish it during life.

For Bibliography, see *Arteritis.*

§ 2. *Constriction and obliteration of the Aorta.* Constriction and partial obstruction of the aorta may take place from different causes, and when they exist in a considerable degree, occasion serious embarrassment of the circulation, by interrupting the free transmission of the blood. A considerable diminution sometimes takes place in the calibre of the vessel, in those protracted diseases which are attended with great emaciation and an imperfect supply of blood, as in anemia, phthisis, &c. This, however, is merely a consequence of enfeebled nutrition, and does not deserve particular attention. More frequently, constriction and partial obstruction depend either upon extensive pathological changes of texture, taking place in the coats of the vessel, morbid growths occurring in its cavities, or tumours, which have their origin from without, encroaching upon its walls. When inflammation affects these structures, plastic lymph is often so freely deposited in their meshes, or interstices, as to occasion a great increase of thickness, which, encroaching

upon the calibre of the vessel, constricts its diameter, and where it is still more considerable, may give rise to a total obliteration. The tunics of the aorta are here thick and indurated, and present but few or none of their natural properties. They are, indeed, often converted into a compact texture, highly resistant, and almost fibrous in its character. The extensive deposits of lymph described above, which sometimes form upon the inner surface of the vessel, and become organized, may in like manner occasion obstruction, either partial or complete. This is the case with the numerous tumours to which allusion has already been made, under the appellation of polypus, and steatomatous tumours of the aorta. They sometimes so nearly fill up the cavity of the vessel, as to leave but little space for the blood to pass, and occasionally, they obstruct it entirely, and finally give rise to complete obliteration. The same effect is sometimes produced by the extensive calcareous deposits which form in the coats of the artery. They may attain so great a size, as nearly to interrupt the transmission of the blood along the course of the artery, or in proportion as these transformations take place, the size of the vessel may become merely narrowed, without the new development forming any considerable projection in the manner alluded to. The aorta is probably not often obstructed by tumours which are formed in the tissues situated in its vicinity; yet such an accident sometimes occurs. In some instances the aorta is also obstructed by fibrinous concretions formed by the blood, which become more or less intimately attached to the internal surface of the artery, and eventually acquire the firm consistence possessed by the lamellated structure which forms within an aneurismal sac.

There is still another species of constriction or obliteration, which is not attended with any very manifest alteration of texture. The vessel presents a narrowed or constricted appearance, at the point affected, as though the circular fibres were preternaturally contracted. There is no thickening of its tunics, but they present their healthy appearance, and are merely so much contracted in a circular direction, as to occasion a slight diminution of the calibre of the artery; or the tube may be completely closed up and obliterated. Most of these cases are probably congenital, and arise from an imperfect evolution of the affected portion of the vessel; but it is possible that a similar change may be gradually acquired, by some irregular action taking place in the fibrous coat of the artery.

Cases of partial obstruction of the aorta, from the development of morbid growths, are so numerous, that we shall not pretend to refer to all those which are on record. Many of the cases already quoted, of tumours affecting its coats, belong properly to this head, and need not be cited a second time. MORGAGNI reports a case, in which the aorta, from the arch to the origin of the emulgent arteries, was reduced to the size of the finger. (*Epist.* XXX. 12.) SANDIFORT (*Obs. Anat. Path.* II. Obs. 10.), MECKEL (*Mém. de l'Acad. de Berlin.* 1756. p. 61.), and MONRO (*Medical Essays.* II. 237.), have reported cases in which the vessel was obstructed by irregular tumours, which were attached to its tunics. Other examples of partial obstruction have been recorded by MORAND (*Mém. de. l'Acad. Royale de Paris.* 1736.) and BRASDOR. (*Recueil Périodique.* III. No. 18.) In MORAND'S case, the disease originated from a contusion of the abdomen.

More recently, a number of examples of this pathological state have been observed by different individuals. In the body of an old woman, which PARIS injected for anatomical purposes, in 1789, he found the aorta, immediately beyond the arch, contracted to the size of a writing-quill. The vessel above the constriction was dilated, as were likewise the trunks which arise from the arch, and their branches. The coats of the aorta were of their proper thickness, and the circulation had been carried on through the anastomoses of the collateral branches, which were greatly dilated, and tortuous. (DESAULT. *Journal de Chirurgie.* II. 108.) The case of a young man, who had been affected with great oppression and palpitation, is described (*Journal de Méd.* XXXIII. 1815.), in whose body the arch of the aorta was dilated to the diameter of nearly four inches, and the vessels which proceed from the affected portion were also so much increased in size, that the left subclavian seemed to be the continuation of the aorta. The descending portion of this latter vessel was diminished in its diameter to about four-fifths of an inch, and six or seven lines below the origin of the left subclavian, it was entirely obliterated, to the extent of a few lines. The ductus arteriosus was open, and was large enough to receive an ordinary catheter. An example somewhat analogous to this has been described by Dr. GRAHAM. (*Medico-*

Chirurgical Trans. V. 287.) The aorta, near its origin, was expanded like a pouch; but after giving off the branches to the head and upper extremities, its diameter was contracted. A little beyond its union with the ductus arteriosus, it was completely obliterated, although there was no thickening or disease of its coats, except that about half an inch below the stricture, there was a smooth elevation of the inner surface, having nearly the diameter of a split pea, but not so much raised. The stricture presented the appearance which would be produced by the application of a ligature to the vessel, and above it, the orifices of three intercostal arteries, dilated to the size of a crow-quill, were discovered communicating with the aorta. The subject of the case was a youth, aged fourteen years, who died of an affection of the chest.

In a case observed by Winstone and Sir A. Cooper, the constriction existed near the same point, but did not amount to a total closure of the aorta, which, at the strictured point, was large enough to receive the tip of the little finger. The circular fibres of the vessel were somewhat thickened, and there were some traces of calcareous transformation. The individual was fifty-seven years old, and had enjoyed good health, except in winter, when he suffered much from an obstinate cough. His death was occasioned by a rupture of the left ventricle of the heart, induced no doubt by the constriction of the aorta. (Cooper and Travers. *Surg. Essays.* Vol. I.) A. Meckel has likewise published a very interesting case, in which the aorta, near the ductus arteriosus, was reduced to the size of a common straw. It occurred in a peasant at Berne, who had enjoyed good health, but was seized suddenly, while carrying a sack of corn, with extreme weakness, which rendered him unable to proceed. He was conveyed to the hospital, where he apparently recovered his health, but afterwards died suddenly, while seated by the stove. The collateral vessels were found enormously dilated, and resembled varicose veins. (Meckel's *Archives für Anat. und Physiologie.* 1827. p. 345, and *N. Amer. Archives of Med. and Surg. Sc.* I. p. 155.) Another example of nearly the same kind has been recorded by Renaud. (*Journal Hebdomad. de Méd.* II. 161, and *American Journ. of Med. Sc.* IV. 208.) It occurred in a shoe-maker, aged ninety-two, who was admitted into La Charité, in 1817, in a very feeble state. The aorta, which for some distance from its origin presented its natural size, was somewhat narrowed beyond the origin of the innominata, and near the ductus arteriosus it presented a very considerable circular contraction, such as would be produced by a ligature drawn very tight. Below this point, it was enlarged, but in the abdominal cavity it was somewhat smaller than natural. Mr. Nixon, of Dublin, has published a case, which may be referred to the same head. The subject of it was a medical gentleman, who, after severe and protracted suffering, died anasarcous. The aorta, in its transverse portion, just at the point where it is joined by the ductus arteriosus, exhibited a very singular constriction, similar to what would occur if a sharp instrument had been pressed upon its upper surface, until it had diminished the calibre by about one half. There was no calcareous deposit in the coats of this portion of the vessel, and the ductus arteriosus was pervious. (*Dublin Journal of Med. and Chemic. Sc.* No. XV. p. 398.) The same gentleman refers to another case, reported by Jordan, in the *North of England Med. and Surg. Journal,* for 1830. The heart was found ruptured, and the constriction, which obliterated the aorta, was situated about three lines below the ductus arteriosus. (Ib. 389.)

In most of these cases, the texture of the arterial tunics was but slightly altered. In some of them, indeed, no appreciable alteration could be discovered. These examples are, therefore, very different from such as are a consequence of degenerations, and other changes taking place in the coats of the aorta. The annals of the science furnish numerous instances of obstruction and obliteration from this latter cause. One of the most interesting, is that recorded by Goodison. (*Dublin Hospital Reports.* II. 193.) The aorta was obliterated from the origin of the inferior mesenteric downwards, throughout the remainder of its length, together with the greater part of the iliacs, on either side. It resembled the trachea in shape, being flattened posteriorly, and the bony casement into which its coats had been converted, was filled up with a compact fleshy substance, which had the firm appearance of the muscular fibre of the heart. In a case observed by Monro, a large tumour, three inches in breadth, occupied the abdominal aorta at its bifurcation. It was hard, and of a whitish colour when cut. A little above it, the vessel was narrowed and completely closed by a conical plug, of a firm consistence, which adhered to each side by dense layers of coagulable

lymph. This plug did not seem to have been formed in *articulo* mortis, but some time before death, and probably by an inflammatory action of the vasa vasorum. (Monro. *On aneurism of the abdominal aorta.* p. 5.; and Guthrie. *Op. Cit.* p. 359.)

A case of obstruction of the abdominal aorta from ossification, amounting almost to complete obliteration, is recorded in Broussais' Journal. The subject of it was the count C., aged 67, who was a free liver, and who died of gangrene of the feet, induced by his habits and the diseased state of the arterial system. About half an inch below the origin of the cœliac artery, the aorta was extensively ossified, and almost entirely obliterated. There were only two small passages for the transmission of the blood, each of which was not more than half a line in diameter. The iliac arteries were also nearly obliterated in several places. (*American Med. Recorder.* XIV. 444.) Another example, in which the aorta was nearly obliterated at two points,—one above, the other below the diaphragm, has been reported by Bright. (*Reports of Medical Cases.*) The obstruction was caused by cauliflower-shaped masses of bony matter, apparently of rapid development. Cases somewhat analogous have been observed by Laennec (*Op. Cit.*), Andral (*Clinique Médicale.* II. 67.), Bouillaud (*Loc. Cit.*), Dalmas (*Dict. de Méd.* 2d edit. III. 400.), and many others.

It has been remarked above, that cancerous degeneration of the aorta is probably of rare occurrence. Velpeau has, nevertheless, reported a very interesting case of obliteration of this vessel, taking place, as he represents, in consequence of the influence of a general cancerous diathesis. The individual was a woman aged thirty-six, who had enjoyed good health up to the age of thirty years. She became affected at that period with a scirrhus tumour, which occupied the anterior and lower part of the arm. It was twice removed by an operation, but was finally succeeded by cough and embarrassed respiration, from which she died. Scirrhus depositions were found in the heart, lungs, pleura, and most of the abdominal organs. The inferior cava was occupied by a cylinder of a grayish colour and fibrous texture, and the aorta, below the third lumbar vertebra, was filled with a cylinder of a yellowish-gray colour, in which was observed a small quantity of puriform matter. (Velpeau. *Exposition d'un cas remarquable de maladie cancereuse avec oblitération de l'aorte.* Paris, 1825. *Medico-Chirurgical Review.* VII. 427. 1827.)

It is somewhat remarkable, that in all the cases we have cited, which were not attended with considerable structural alterations of the coats of the aorta, occurred in the immediate vicinity of the union of the ductus arteriosus with that vessel. This point was the seat of stricture in the cases reported by Paris, Corvisart, Winstone and Sir A. Cooper, Albert, Meckel, Renaud, Nixon, and Jordan. Another interesting feature in two of these cases,—those reported by Corvisart and Nixon, is, that the ductus arteriosus was found open, and in one of them, was large enough to receive a catheter. In all the others, it is either described as being impervious, or is not noticed. The constancy of the constriction or obliteration at this point, and its intimate relation with the ductus arteriosus, together with the absence of any very manifest thickening, or other alteration of texture of the coats of the artery, render it highly probable, that these cases, or the majority of them at least, had their origin in a defective evolution of this portion of the vascular system, owing to some interruption or disturbance of the natural process of development. This pathological condition of the aorta, when it presents the characters which it did in the cases referred to, may, therefore, be regarded as of the same nature as the examples of congenital atresia of different portions of the alimentary canal, the urethra, vagina, &c., which are so often observed.

The other cases, however, are of a different nature. They manifestly had their origin in a diseased state of the coats of the aorta, and the obliteration and constriction were induced by the transformations of which these structures were the chief seat.

In both classes of cases, the circulation was carried on through the same collateral channels. The branches given off above and below the point of obstruction, were enormously dilated, and by means of their extensive anastomoses with each other, a sufficient quantity of blood was transmitted through the numerous channels thus formed, to compensate for the interruption of its course through the main trunk. Above, the subclavians, the transverse cervical, supra-scapular, internal mammary, superior intercostal, and the thoracic arteries, were generally found greatly dilated, and presenting a tortuous appearance, analogous to that exhibited by varicose veins. Lower down, the intercostal, lumbar, circumflexus ilii, and epigastric arteries were

found in the same condition; and the latter especially, from its intimate anastomoses with the internal mammary artery, furnished an important channel for the transmission of the blood.

One would be disposed to infer, *à priori*, that such a state of the aorta must be necessarily productive of serious disturbance of the functions of the organs, and that it could scarcely fail to lead to fatal consequences. While such a conclusion is justified by the result of many cases, it is invalidated by the phenomena of others. In some instances, the collateral circulation has accommodated itself so readily to the exigencies of the system, that little or no inconvenience was experienced, and the individuals enjoyed good health, and some of them attained a considerable age. More frequently, however, considerable functional disturbance, and in some cases great suffering, were experienced. The obstacle to the passage of the blood gave rise to dilatation and hypertrophy of the heart, frequent palpitations, dyspnœa, congestions of the lungs, with cough, hæmoptysis, and effusions into the pleura and pericardium,—cerebral congestions, apoplexy, and other affections of the brain. In some of the cases reported, the embarrassment of the heart was so great, as to occasion death by a rupture of its parietes. The parts which are situated below the point of constriction, generally languish for want of sufficient blood to maintain their nutritive functions;—they become atrophied, lose all their energy, and sometimes fall into a state of gangrene. as happened in the case of the count C., referred to above. These consequences are, nevertheless, sometimes obviated by the collateral circulation accommodating itself promptly to the wants of the organization, and compensating for the interruption of the aortal circulation, by transmitting an adequate supply of blood through its numberless channels.

We are unfortunately in possession of no data, upon which a *diagnosis* of constriction of the aorta can be predicated. All the derangements alluded to above, may be produced by other causes, and are consequently insufficient to justify any conclusion. Bouillaud and Renaud have suggested, that when an extraordinary dilatation of the collateral circulation is observed, attended with preternatural pulsation, especially of the epigastric and other superficial arteries, constriction may be presumed to be the cause. If with this condition of these vessels, they present a tortuous or varicose arrangement, such as that which is often observed in the superficial veins, when the great venous trunks are obstructed, there will be additional reason to suspect the existence of some impediment in the course of the aorta. Yet even these symptoms are equivocal, and can only furnish presumptive evidence—as they may be induced by other causes.

If the disease could be discovered, life might be prolonged in some cases, by frequent and small abstractions of blood, by a properly regulated diet, an avoidance of all sources of irritation, and the employment of all those means which are calculated to moderate the activity of the circulation. The treatment, in short, would be the same that is proper in aneurism (q. v.).

§ 3. *Dilatation of the Aorta.* Aortaektasis. (From αοςτη, aorta, and εκτασις, dilatation.) By this term is meant a general dilatation of all the coats of the aorta, occupying more or less of the extent of that vessel. It is distinguished from aneurismal dilatation, by the latter being generally, though not always, confined to a limited extent of the aorta; by the presence in aneurism of a tumour more or less manifest, either occupying the entire circumference of the vessel or confined to a portion of its walls; and finally, by the absence in simple dilatation, of those laminæ of coagulated blood and fibrinous depositions, which always form within an aneurism, and become intimately connected with the inner surface of the sac. (See *Aneurism.*)

Notwithstanding these obvious distinguishing characters, the two diseases were for a long time confounded under the appellation Aneurism. Some of the earlier writers on that disease maintained, indeed, that it always commences by a simple dilatation of the coats of an artery; and this opinion was particularly espoused by Fernelius, Forestus, and Diemerbroek, but was opposed by M. Severin, Fabricius Hildanus, and others, who adopting the views of their predecessors, referred all cases of the disease to rupture of the tunics of an artery. Vesalius, however, described a case of aneurism, which commenced by simple dilatation, but terminated by rupture; and as a similar condition was observed subsequently by others, a majority of pathologists concurred in admitting, that the disease might proceed either from dilatation or rupture. Hence, aneurisms were divided into true or false, according as the disease had its origin in the one or the other of these causes. Scarpa first called in question

the correctness of this distinction, and in his excellent treatise on the subject, denied the existence of such a disease as true aneurism. Subsequent observations have fully refuted this sweeping conclusion, and a sufficient number of unequivocal cases of true aneurism have been noticed, to establish the propriety of the former division of the disease into true and false. It is, nevertheless, but just to Scarpa to remark, that he admitted the existence of a species of dilatation of the arteries; and, in a later work, he particularly adverted to this form of disease, which he contends, we think very properly, should be distinguished from aneurism. (*Opuscoli di Chirurgia.* II. 109. Pavia, 1825, and *Appendice all' Opera sull' Aneurisma.*) The same grounds have been taken by Hodgson; and, although the existence of true aneurism is now very generally conceded, nearly all pathologists concur in the propriety of not confounding with it that preternatural dilatation of all the coats of an artery, which is not attended with the formation of a distinct sac or pouch, and in which no lamellated coagula are deposited within the dilated portion of the vessel.

Preternatural dilatation of the aorta is of very frequent occurrence. Its most common seat is that portion of the vessel included between its origin from the left ventricle, and the termination of the arch. It may, however, occupy any part of either the abdominal or thoracic aorta. The form assumed by the dilatation, its degree, and the extent of the vessel involved, are infinitely variable. In most cases it will be either cylindroid, fusiform, or sac-like in appearance; and, as a general rule, a greater extent of the vessel will be involved when it assumes either of the two first forms, than when it presents the last character. In the sac-like dilatation the tunics are often distended only in one direction, and preserve their integrity so far, that no lamellated coagula, or other deposits, are formed upon their inner surface. Where the whole arch, or a considerable extent of the aorta, becomes greatly dilated, there are often several points affected with this partial lateral dilatation, which occasion an uneven appearance upon the surface of the vessel, not unlike the protuberances of the outer surface of the colon. These sac-like prominences mostly occupy the convex face of the arch, or the anterior portion of the artery, and vary considerably in size—some of them being scarcely larger than a pea, while others are so prominent as to project considerably beyond the adjacent portion of the vessel. They are often attended with considerable thinning of the corresponding portion of the arterial tunics; and, in many instances, fissures, erosions, or ulcers of the inner membrane, are observed, manifesting a tendency to the development of aneurism. When several dilatations exist upon different portions of the aorta, the intermediate parts are sometimes but little altered in their diameter; but, in some instances, the whole extent of the vessel, from the heart to the bifurcation of the iliacs, is involved in one general cylindroid dilatation, either uniform or irregular. In cases of this kind, the length of the artery, as well as its diameter, is increased; so that while the upper margin of the arch ascends to the level of the top of the sternum, or even into the lower part of the neck, the thoracic and abdominal aorta assume a flexuous arrangement, similar to what is presented by a large varicose vein, or the convolutions of an intestine. This condition was observed in a case of dilatation of the aorta described by Hunter. The length of the vessel was so much increased, that it formed several flexures between the summit of the thorax and where it glides between the fissures of the diaphragm.

Sometimes the aorta is only dilated above the semilunar valves, where it becomes distended in form of a large ovoid sinus, capable of receiving the tips of the whole of the fingers. In nearly all cases in which the dilatation exists at the origin of any of the vessels which proceed from the aorta, they, in like manner, participate in the distention. (Hodgson. Erhardt, *de Aneurismat. aorta comment. anat. path.* p. 5. Lips. 1820.) This is especially true of the coronary arteries—those vessels which proceed from the arch, and the cœliac. There are, nevertheless, some exceptions. Laennec has remarked, that the left subclavian artery is seldom dilated, even though the arch of the aorta be greatly distended.

The degree to which the dilatation may extend, without a rupture taking place, is very considerable, especially when the disease is confined to a small extent of the vessel, and assumes the fusiform or sac-like arrangement. Scarpa reports a case in which the sinus of the aorta, above the valves, was so dilated that the tumour measured eight inches in height, and five in diameter, (*Opusc. di chirurg.* II. 112.) although no coagula or lamina had formed upon its inner surface. A similar case has been described by Bertin and Bouillaud, (*Traité des malad. de cœur*, &c. 104. Paris, 1824.) and many, of a like charac-

ter, have been recorded by different writers. Even when the whole extent of the aorta is involved in the dilatation, the size may be enormously increased. The case reported by Hunter, already referred to, furnishes an example of this extraordinary expansion of its coats. Bertin and Bouillaud remark, that it is sometimes dilated to triple or quadruple its natural size, so as to resemble the colon; (*loc. cit.* 121.) and Laennec observes, that in some cases this vessel, from the heart to the bifurcation of the iliacs, is distended to the diameter of two fingers' breadth. (*De l'Auscult. mediat.* II. 689. Paris, 1826.) By Testa it is described as being occasionally dilated, throughout the whole of this extent, to more than three times its natural volume (*Malattie del' cuor*, &c. Bologn. 1810–1811.); and a case is reported by Paschalis Ferraria, in which the orifice of the aorta was extended to such a degree, as to receive the arm. (*Delle morti et malattie subitance*, apud Burserius, *loc. cit.* 225.)

Dilatation of the aorta seldom exists to a great extent, without being attended with more or less change of the texture of its tunics, and considerable modification of its physical properties. The coats of the vessel become compact and rigid, and are in most cases much thickened. When the dilatation is considerable, the artery is divested of all its suppleness and elasticity, and is frequently found flattened and collapsed after death. Its fibrous tunic, which is generally thickened, is remarkably fragile; and, between it and the lining membrane, the whole walls of the vessel are studded over with scales, or plates of calcareous deposit, some of which even project through the delicate internal membrane, and are in immediate contact with the blood. In many cases, where these calcareous transformations do not exist, the internal surface of the vessel presents an infinity of minute specks of a yellowish colour, or there are numerous erosions, or abrasions of the internal membrane;—sometimes small cracks, fissures, or even ulcers; and, in some instances, there is at many points a species of atheromatous or tuberculous degeneration. The external coat, though thicker and denser than natural, is so brittle that it can be torn by the slightest force. In some few instances, indeed, the whole of the coats become so fragile, that they are incapable of resisting the impulse and distending force of the column of blood, and sudden death is induced by rupture. The same event may be induced by an ulcer implicating the coats of the vessel; and it is not unusual for dilatation to be followed or accompanied by such a condition, which, when it takes place, if it does not terminate in perforation, is apt to give rise to aneurism. In some instances of dilatation of the aorta, the brittleness or fragility of the coats adverted to, is confined to the serous and fibrous tunics; the cellular being highly compact and resistant, but devoid of elasticity.

It has been remarked, that one important distinction between simple dilatation and aneurism is, the absence in the former of those lamellated fibrinous concretions, which always exist in the sac of the latter. To this, however, there are some apparent exceptions. Examples of dilatation occur occasionally, in which the inner surface of the vessel is found lined by these formations, and sometimes even by proper pseudomembranes, indicating the previous existence of aortitis. In the thirty-sixth case reported by Bertin and Bouillaud, the aorta was lined by a cylindrical coagulum, which prevented the blood from being extravasated through the numerous ulcers occupying its coats. (*Op. cit.* p. 88.) Mr. Guthrie also refers to similar examples in the Hunterian Museum; and very correctly remarks, that when dilatation has proceeded to a great extent, coagula are often found in the vessel; but they have more the appearance of accidental, irregular formations, than of deposits in concentric layers. When, however, the inner coat has suffered abrasion or rupture, coagula may be deposited in layers, although not to the same extent as in a small, or even recent aneurism. (*On the Diseases and Injuries of the Arteries.*)

It is difficult to determine satisfactorily what particular modification of the properties of the coats of the artery is instrumental in giving rise to this pathological state, and how far it is attributable to vital, and how far to mechanical influences. The latter certainly operate in some cases; yet unassisted they are not adequate to produce the effect. Hence it has been supposed by some, that dilatation of the aorta, or at least the predisposition to that state, is owing either to a state of atony or paralysis of the coats of the vessel, or to the pre-existence of chronic inflammation, by which they are first softened and divested of their elasticity, and afterwards dilated, because of their inability to resist the distending force of the natural impulse of the blood. The former cause, we doubt not, is efficient in some cases, especially when associated with active hypertrophy of the left ventricle, or any condition of the heart calculated to occasion it to communicate

a preternatural impulse to the blood, or when it coexists with an obstacle to the free transmission of that fluid. It is nevertheless probable, that the dilatation is more frequently attributable to a state of chronic irritation, modifying the nutrition of the arterial tunics; since the traces of this pathological state which are so often observed,—the alterations of colour; the thickening and alteration of the textures of the several coats; the pseudo-membranes; abrasions; ulcerations; osseous transformations; the atheromatous deposits, &c., all seem to point to this cause as the principal source of the mischief. It has been ascertained, moreover, that inflammation of the coats of an artery always renders them soft and fragile, and destroys their elasticity; and these conditions once induced, the impulse of the blood would be amply sufficient to give rise to the dilatation, because the coats of the aorta would be no longer able to afford that resistance which they do in a state of health.

The symptoms which attend this disease of the aorta, are not sufficiently dissimilar to those which characterize some of the forms of aneurism, to enable us to distinguish the two diseases. In some cases, indeed, where the dilatation is not considerable, there being no coagula or preternatural deposits within the vessel to interrupt the stream of blood, or embarrass the circulation, little or no inconvenience is experienced. When the disease is more formidable, there are often violent pulsations in the course of the aorta, great embarrassment and irregularity in the actions of the heart, frequent palpitations, suffocation, syncope, and the usual phenomena which indicate disease of the heart, or aneurism of the aorta.

The disease, we have remarked, has considerable tendency to terminate in the development of aneurism. Sometimes, however, the coats of the artery become so far divested of their cohesiveness, that rupture takes place, and the individual is destroyed by a sudden extravasation of blood. Dilatation may nevertheless exist in a very considerable degree, without occasioning either of these consequences, and continue throughout a series of years, with very trifling disturbance of the functions. Like diseases of the heart, however, it is very apt to occasion serous effusions, and destroy the patient by general dropsy.

Preternatural dilatation of the aorta, when it is known to exist, must be treated upon the general principles which have been laid down for the management of chronic aortitis; and when its symptoms are urgent, the course prescribed for the treatment of aneurism will be proper.

§ 4. *Aneurism of the Aorta.* The observations which are to be made under this head, are intended to apply to aneurism proper, in contradistinction to simple dilatation of the aorta, which has been already described. The division of the disease into true and false aneurism, will likewise be retained; inasmuch as, notwithstanding the opinion of Scarpa that such a form of the disease does not exist, a sufficient number of authenticated cases have been examined, to establish an opposite conclusion. It must be confessed, however, that true aneurism is comparatively rare, and that a very large proportion of cases are of that variety, denominated false aneurism.

1. *Anatomical Characters of Aneurism of the Aorta.*

A. *True Aneurism.* True aneurism, like simple dilatation, may assume either a sac-like, a fusiform, or a cylindroid shape. The first is perhaps the most frequent:—the last, the rarest form of the disease. In the first, the dilatation generally takes place upon one side of the vessel, and all the coats participate in the distention. This gives rise to a tumour more or less considerable, upon the corresponding portion of the vessel, which is generally rounded, but not unfrequently uneven upon the surface. The principal seat of these tumours is the ascending portion of the aorta and its arch, the anterior or lateral faces of which are most frequently affected. Their size is seldom considerable, owing to the resistance of the middle coat; but in some instances, when seated upon the substernal portion of the vessel, they have been known to attain a great magnitude, inclining towards the right side of the thorax, and forcing the left lung upwards and backwards. (Bouillaud.) When carefully dissected, the walls of such aneurisms are found to be composed of all three of the coats of the aorta, the distended portions of which are either thickened or attenuated, and frequently present traces of chronic inflammation, either characterized by alteration of colour, or some of the modifications of texture already described. In some instances, the sac communicates with the cavity of the vessel by a narrow neck, in which all the tunics can be recognized. This disposition, however, is not always observed; the dilatation in some cases occupying the coats of the artery to a greater extent, and

allowing a freer communication between it and the sac. The latter contains more or less coagulated blood, which is often disposed in irregular confused masses, but is occasionally deposited in distinct layers, which form a concentric series.

Although true aneurisms of this kind take place in the portions of the vessel indicated, they are not confined to these points, but may occur in any part of either the thoracic or abdominal aorta. NÆGELE has reported a case, in which a true aneurism, which had attained the enormous weight of five pounds, occupied the latter portion of the vessel, immediately beneath the point at which it emerges from between the pillars of the diaphragm. It was found on dissection, that all three of the aortal tunics entered into the formation of the sac, which was filled by a mass of fibrinous concretions of a firm consistence, and of a whitish red colour, inclined to yellow. (D. Fr. NÆGELE. *Epist. quâ hist. aneurismat. in aort. abd. continent.* Heidelburg, 1816.) JULES CLOQUET has likewise reported a case of true aneurism of the abdominal aorta, which was situated immediately above its bifurcation. The cavity was filled with superincumbent layers of fibrinous concretions, in the centre of which was found an artificial canal, through which the blood passed. (*Surgical pathology*, &c., translated by GARLICK & COPPERTHWAITE. p. 114. pl. 3. Lond. 1832.) In some cases, indeed, different portions of the aorta are simultaneously the seat of aneurism; and instances occasionally occur, in which the whole arterial system is affected in this way. The author just cited, has published a case of this kind. The tumours varied in size, from a hemp-seed to a large pea. Some of them were found upon the aorta and its principal divisions; but these were less prominent, and fewer in number, than those upon the arteries of the extremities, which were so closely clustered together, that they formed strings of knots; and even those of the lower extremities, which were the least numerous, amounted to several hundreds in number. In none of these tumours was any rupture of the internal or middle coat observed; nor in any of the arteries, was there ossification, or steatomatous degenerescence. (*Op. Cit.* p. 105. pl. 2.) PELLETAN also met with a case, in which sixty-three aneurisms, from the size of a filbert to that of an egg, occupied the arterial system of an individual. (*Clinique Chirurgicale.* II. 1.)

The fusiform variety of true aneurism, is intermediate between the sac-like, and the cylindroid:—it represents the transition from the one to the other. Like the preceding variety, its most frequent seat is the ascending portion of the aorta and its arch. It is generally characterized by a uniform dilatation of the coats of the vessel in every direction, which, at the same time, present the usual evidences of chronic inflammation that are observed in the other forms of the disease. They are friable in their texture, and of an unequal thickness,—being attenuated at some points, and at others considerably thickened. Sometimes, moreover, the lining membrane is rough upon the surface, and presents numerous fissures, while between it and the fibrous coat, there are often plates of calcareous deposit. These tumours, though often small, in some instances attain a great size. BRESCHET has reported two interesting cases. In one, the tumour which occupied the thoracic aorta, on a level with the eighth and ninth dorsal vertebræ, measured three inches in diameter and four inches in length: in the other, which extended from the sigmoid valves to the origin of the innominata, the diameter of the tumour was five inches. (*Mémoires Chirurgicaux sur differentes especes d'aneurismes.* p. 15–23. 4to. Paris. 1834.) In both these cases, the tumour was occupied by coagulated blood, and in one of them, by lamellated fibrinous concretions. Other cases of the same kind might be cited; and in the work just referred to, pl. iv., a very interesting one, which was observed by AMUSSAT, is figured.

The cylindroid variety of true aneurism of the aorta is exceedingly rare. We know of no well authenticated case in which there was not rupture of the internal coat of the artery. The nearest approximation to this condition, of which we have any knowledge, is the case reported by HUNTER, to which reference has been made already, under the head of dilatation. It may be remarked, however, that aneurism often takes on a mixed character; viz.—consisting at first of a dilatation of all the coats of the aorta, the two internal tunics finally give way, and the external becomes dilated, to form the sac. We shall have occasion, therefore, under the next head, to speak of examples of cylindroid aneurism of this great vessel, with dissection of the internal tunic, and shall merely observe at present, that although true aneurism of the aorta, and other large

vessels, seldom assumes the cylindroid form, it is not uncommon in arteries of smaller calibre.

B. *False Aneurism.* This variety of aneurism, the distinctive characters of which are a destruction of the internal and middle coats of the artery, with a dilatation of the external, occurs much oftener than the preceding. Like that form of the disease, its most common seat is the ascending aorta, or the arch, especially that portion of it which gives off the innominata. No part of the vessel, however, is exempt,—cases frequently occurring either in its thoracic or abdominal portions. The part immediately beyond the termination of the arch, that in the vicinity of the pillars of the diaphragm above and below, and the origin of the cœliac artery, and finally the vicinity of the bifurcation, seem to be most liable to the disease. In some cases, several aneurisms exist in different portions of the vessel,—one or more of these being large, while the others are comparatively small. The shape of the tumour, as in true aneurism, may be either sac-like, fusiform or cylindroid, though the first is by far the most common, because of the tumour being generally developed upon one side of the artery. The last is very rarely observed. The volume of the tumour varies, according to the degree of resistance afforded by the surrounding parts,—sometimes attaining the size of the head of a full-grown child, when they are yielding, but when they are resistant, being much smaller. It should be remarked, however, that when an aneurism takes place upon that portion of the aorta which is included within the pericardium, the tumour seldom attains a large size, because the cellular coat of that part of the vessel being exceeding feeble, the tumour is generally ruptured, before its volume can become considerable.

The manner in which a false aneurism of the aorta has its origin varies in different cases. In a majority of instances, the development of the tumour is preceded by a solution of continuity of the internal and fibrous coats of the vessel, produced either by ulceration, atheromatous degeneration, or calcareous deposits, formed between them, and projecting through the former into the cavity of the artery. Under these circumstances, the cellular coat has to sustain the whole force of the lateral distention of the blood, and as it yields readily to this influence, it becomes distended, the blood insinuates itself between it and the fibrous coat around the solution of continuity, and in the end, a sac or pouch of variable magnitude is formed, which is filled with blood, and communicates with the cavity of the aorta. Such tumours are at first confined to one side of the aorta, generally to its anterior, superior, or inferior faces; but as they augment in size, a greater extent of the circumference becomes implicated, and in some cases the tumour surrounds the whole contour. But while false aneurism generally has its origin in this way, there are cases in which its development is preceded by changes which are slightly different. Thus, the simple dilatation of the aorta occasionally gives rise to fissures of the lining membrane, which are probably not so much owing to the mere mechanical influence of distension, as to a diminution of the cohesiveness of the tissue, induced by disease. These fissures are mostly transverse, but occasionally longitudinal or oblique;—the blood insinuates itself beneath the edges of the membrane, and by gradually detaching it from the tunics which are exterior to it, sometimes dissects the coats of the artery for some distance. In some cases, the fissures extend in like manner through the fibrous coat, and the cellular undergoes the same modifications, as when the disease has its origin in the manner described above. The cause of this accident is a preternatural friability of tissue, excited by previous disease, which renders the arterial coats incompetent to resist the force of the lateral distention of the column of blood; and if it exist simultaneously in the cellular coat, complete rupture, instead of aneurism, will sometimes ensue. An approximation to this condition was found by Nicholls, in the body of George II. A fissure, ranging in a transverse direction to the extent of an inch and a quarter, was found occupying the aorta, and a small quantity of blood extravasated beneath the cellular coat of the vessel. Rupture probably would have taken place in a short time, had it not been that death occurred too early to allow the necessary changes to ensue.

The best example of dissection of the coats of the aorta by aneurism, is one reported by Laennec. (*Auscultation médiate.* II. 700.) The arch of the aorta was dilated to such an extent, as to be capable of containing an apple of medium size. The descending portion of the vessel, two inches below the termination of the arch, presented upon its inner surface, a transverse fissure, which occupied two-thirds of its circumference, and extended through

the internal and fibrous coats. The edges of this division were thin, uneven, and of a lacerated appearance at some points. The cellular coat was healthy, but detached from the fibrous, from the fissure in question, to the origin of the iliacs; so that at first view, the cavity of the aorta seemed to be divided into two, by an intermediate partition. The detachment occupied about two-thirds or half the circumference of the vessel, and was principally confined to its posterior portion, though it occasionally wound around it. In the cœliac and primitive iliac arteries, upon which it extended for some distance, it was complete.

Two similar cases are mentioned by Guthrie (*Loc. Cit.* 40. 43.); but in them, the dissection or detachment of the cellular from the fibrous coat was less extensive. In one of them, the separated cellular tunic formed a long pouch on the anterior part of the descending aorta, about six inches in length, extending to the sides, and in one place nearly surrounding it. A horizontal fissure, about half an inch in extent, near the upper part of the swelling, allowed the blood to pass through the inner and middle coats, and to effect this separation, which could only have arisen from disease previously existing in the part. The other case was that of an old woman who died suddenly. The ascending portion of the aorta was greatly dilated, and of a red wine-lee colour. Just below where the innominata is given off, the inner and middle coats were ruptured, for half the circle of the vessel, on the great curvature, as clean as if cut with a knife, and in a straight line around. The effused blood separated the outer from the fibrous coat, down to its origin, along the fore part and around the great curvature, to the back part, dissecting thereby two-thirds of the artery. The dissecting process was also extended for an inch beyond the left subclavian, along the descending aorta. For additional cases of the same kind, see *Aneurism*, Vol. I. p. 498.

Under the head constriction and obstruction of the aorta, reference was made to a species of lesion of that vessel, which was supposed by Corvisart to constitute a cause of aneurism. The condition to which we allude was a kind of fibrinous cyst, developed upon the course of the vessel, of about two lines in thickness, which contained a substance somewhat softer than suet, of a deep red colour, and analogous in appearance to the ancient coagula which adhere to the inner surface of an aneurismal sac. Corresponding to the site of the tumour, the external tunic of the aorta was destroyed, and the remaining portion of the wall of the vessel was greatly attenuated. (*Essay on the organic diseases of the Heart*, &c. American edit. p. 241. Philad. 1812.) He observed two cases of this kind, and others have been noticed subsequently, by several pathologists. Hodgson, however, has argued to prove that these tumours should not be considered as a cause of aneurism, but the remains of that disease, where a cure has taken place spontaneously. This view has been adopted by Bouillaud and a majority of the pathologists of the present period, and is probably much more correct than that advanced by Corvisart.

C. *Mixed Aneurism.* This term has been variously applied by different writers. We shall employ it to express a form of aneurism, which consists of a destruction of the two external coats of an artery, and a protrusion of the internal tunic through the opening, after the manner of a hernial sac. Haller first demonstrated, by experiments made on the mesentery of frogs and other animals, the possibility of such a disease, and similar conclusions were adopted by William Hunter. The disease has been denominated *internal mixed aneurism*, and it is said that Dupuytren and Dubois some years since presented examples of this form of disease to the Faculty of Medicine of Paris. Many pathologists, however, still question the existence of such a form of aneurism, and it must be acknowledged that such an occurrence is exceedingly rare. It is possible, nevertheless, when the fibrous and cellular coats of an artery have been destroyed by previous disease, for the serous coat to become sufficiently fortified by an adventitious deposit of lymph upon its outer surface, to become distended, or protruded, in the manner represented, without being immediately ruptured by the lateral impulse of the column of blood. Without this preliminary change, we conceive such an event would be impossible; but with it, an aneurism of the kind in question might possibly be developed in the aorta, or some of the larger arteries. Trousseau and Leblanc have, indeed, reported a case, in which an aneurismal tumour of this kind was found in the aorta of a horse (*Archiv. Générales.* XVI. 189.), and Lauth reports an instance, in which three such tumours occupied the aorta of one subject. (Lobstein. *Traité d'Anat. Path.* II. 583.) Dupuytren also disco-

vered two aneurisms of the popliteal artery, situated an inch apart,—one as large as a pigeon's egg, the other of the size of an almond, in which it was found that the internal and external tunics were dilated, while the fibres of the middle coat were forced asunder, to allow the inner tunic to protrude through it. (*Archiv. Générales.* XXIV. 143.)

The condition of the sac, and the changes which take place within it, have been so fully described under the head *Aneurism*, that we shall merely refer to that article, for information on these topics. (See *Aneurism*, Vol. I. p. 497, *et seq.*)

2. *Of the influence exercised by Aneurism of the Aorta upon the adjacent parts.* Aneurisms of the aorta, whatever their situation, necessarily encroach more or less upon the surrounding parts, according to their size; and when the organs which are in contact with the tumour are so firmly fixed that they cannot yield, serious embarrassment of function will be produced. Hence, aneurisms affecting the ascending aorta, and the arch, occasion more disturbance than those which attack the abdominal portion of the vessel. The organs in the latter cavity, indeed, yield so readily, that the simple pressure of an aneurismal tumour, except when its volume is very enormous, seldom occasions much inconvenience, although it may give rise to formidable consequences in a different way. The thoracic organs, on the contrary, being surrounded by bony walls, suffer much from such pressure. Thus, an aneurismal tumour of the arch, may encroach so much upon the trachea and bronchia, as to embarrass respiration: it may impede deglutition by encroaching upon the œsophagus; force the heart and lungs out of their natural situation, and interrupt their functions; obstruct or obliterate the vena cava, vena azygos, and other great veins in the upper portion of the thorax; compress the important nerves; obstruct the thoracic duct,—in short, displace nearly all the important organs of the thorax, destroy their relations, alter their texture, and finally deform or break up the walls of the cavity itself.

Instances of compression of the trachea from aneurism of the arch, are of common occurrence. Within a few days we have dissected an interesting case of this kind, which occurred in an individual who had been for a long time suffering from symptoms of asthma. An aneurismal tumour of small size, occupied the posterior face of the vessel, where it passes in front of the trachea, and the cellular coat adhered so intimately to the anterior part of the trachea, that the latter, which was a little indented upon its inner surface, closed up the aneurism, and prevented it from rupturing. The pressure was still further increased, by a considerable glandular tumour, which was wedged in between the anterior surface of the arch, and the corresponding portion of the sternum. When the pressure upon the trachea is considerable, the respiration is generally laborious or wheezing, and the case is apt to be mistaken for asthma. In some cases, when an aneurism of great size exists near the origin of the aorta, the tumour encroaches upon, and displaces the heart. Neumann has reported a very interesting example of this kind, in which the tumour covered the whole extent of the right ventricle of the heart, and even extended beyond its limits, downward and on the right, while on the left, it reached the line of the interventricular septum, and forced the heart backward towards the spine. (*Journal Complimentaire.* V. 87. Paris, 1819.) Laennec saw a case in which the tumour obstructed the thoracic duct, and occasioned engorgement of all the lacteal vessels. Corvisart and Bouillaud found the superior vena cava so much compressed by an aneurismal tumour, as to occasion frequent attacks of cerebral congestion and apoplectic symptoms. (*Dict. de Méd. et de Chir. Prat.* II. 403.) Beevor related a case to the Westminster Medical Society, in which the vena cava, about an inch above the auricle, was impervious to the extent of half an inch, and communicated by a rent, higher up, with the cavity of the enlarged aorta. (*Lancet.* II. 63. 1832–33.) In another case, observed by Reynaud, the superior cava was nearly obliterated by an aneurism of the ascending aorta. Besides being flattened by the tumour, it was occupied by a fibrinous concretion, which allowed merely a small stream of blood to reach the auricle. (*Journ. Hebdomad.* II. 109.) Sometimes the common carotid artery is obliterated (Sir A. Cooper. *Med. Chir. Transact.* I. 12.), and the subclavian may experience a similar change. (Hodgson. *Loc. Cit.*) Serious inconvenience may likewise arise from the pressure of the tumour upon the pneumogastric or recurrent nerves. Huguier and Cruveilhier have reported cases, in which aphonia was induced by the compression of the recurrent nerves. In the instance reported by the first individual, there was also great difficulty of breathing, in consequence of the encroachment of the an-

eurismal tumour upon the left bronchus. (*Archiv. Gén.* Feb. 1834.) Pressure upon these nerves and the phrenic, may likewise occasion much pain and suffering. (Paillard. *Journ. Hebd.* No. 45. *Dict. de Méd.* III. 308.)

When the tumour attains a greater volume, it not unfrequently protrudes from the cavity of the thorax in the direction in which it encounters the least resistance,—sometimes, however, even destroying the bones in its progress. When it occupies the arch, it is apt to ascend from beneath the sternum into the lower part of the neck, in which situation it may be mistaken for an aneurism of the innominata. It also protrudes, in some instances, upwards and laterally, behind the clavicle, and in such cases great care is requisite not to confound it with an aneurism of the subclavian artery. Occasionally it destroys the sternum, and protrudes through it; occasions absorption of one or more of the ribs; gives rise to curvature, luxation, or distortion of the clavicle (Guattani, *apud* Lauth. p. 168.), and even inflicts its ravages upon the scapula. (Duverney.) When the descending portion of the aorta is the seat of the tumour, the bodies of the vertebræ are frequently destroyed to a considerable extent, and if the tumour be large, destruction of the adjacent portion of the ribs often takes place either by absorption or caries. In large aneurisms of the abdominal aorta, the kidneys and intestines are frequently forced out of their natural position, and the tumour may descend into the cavity of the pelvis, or even reach below Poupart's ligament, as happened in a case reported by Elliotson.

All these effects are sufficiently formidable, and many of them are not unfrequently fatal, in consequence of the serious disturbance of function with which they are associated. Yet in proportion as the disease makes progress, others of a more alarming nature ensue. As the volume of the tumour increases, important alterations take place in its walls. Adhesive inflammation is developed in the structures which compose them, as well as in the surrounding parts: adventitious attachments form between the sac and the parts with which it is in contact, and the parietes becoming attenuated, or softened, by disease, or destroyed by ulceration or interstitial absorption, the aneurism either bursts into some of the natural cavities, or the hollow organs, or it makes its way externally, and its contents finally find an exit through the skin. Such an event is almost always immediately fatal, yet in some instances death has not ensued for some time subsequent to the accident,—the fatal termination having been averted, by the aperture being closed up by a coagulum.

It has been already remarked, that when an aneurism occupies that portion of the aorta which is contained within the pericardium, rupture takes place readily, on account of the great thinness of the cellular coat of that portion of the artery. Aneurisms, therefore, often rupture into the cavity of this membrane, and the heart is found after death completely embedded in a mass of coagulated blood. We have observed two or three cases of this kind, and examples are so numerous, that we need not refer to particular ones. Next in point of frequency, is the rupture of the aneurism into the cavity of the pleura, especially the left, extravasation into the right being comparatively rare. Rupture into the cavity of the abdomen is likewise common; and in some instances, when the descending aorta is affected, the tumour bursts into the posterior mediastinum (Wolff. *Nov. Act. Petrop.* V. 1786. Hodgson. *Op. Cit.*), or into the anterior mediastinum, as happened in a case reported by Reguier to the Anatomical Society of Paris. (*Rev. Méd.* I. 315. 1834.)

Less frequently, the tumour forms a communication with some of the hollow organs. Of these openings, those into the trachea and œsophagus are the most common. Cases of communication with the trachea have been reported by Heurnius (in Lieutaud. *Hist. Anat. Méd.* II. Obs. 802.), Corvisart (*Loc. Cit.* 256.), Boyer, Richerand (*Mém. de la Soc. d'Emulat.* IV. année.), Bouillaud (*Traité des maladies de Cœur*, &c. 107.), Lambert (*Journ. des Progrès.* III. 1830., and *Amer. Journ. of Med. Sc.* VII. 229.), Wright (*Amer. Journ. of Med. Sc.* IV. 345.), Regnier (*Revue Méd.* I. 315. 1834.), Corbin (*Journ. Hebd.* III.), Montault (*Lancette Française.* No. 9. Sept. 1834.), and others, whose observations are not at hand.

The walls of the œsophagus being thin and destitute of the cartilaginous structure which forms so considerable a portion of the trachea, cannot resist so effectually the progress of the ulcerative inflammation which takes place in the sac. Hence aneurisms of the thoracic aorta, which contract adhesions with this tube, often terminate by forming an opening into its cavity. The records of the science furnish numerous cases of this kind, but as only a few of them have been indicated in the ordinary systematic works, the following

references to the principal examples which have been reported, may serve to facilitate the further investigation of the subject. (MATANUS *de Aneuris. præcord. morb.* VI. 120. SAUVAGES. *Nos. method.* II. 388. Amst. 1768. *Eph. de Montpel.* VI. 219. *Philosoph. Transact. abridged.* II. 420. DUPUYTREN, *in* CORVISART *Op. Cit.* 256. *Bulletin de la Soc. d'Emulat.* 1812. p. 14. OUVRARD. *Thèse* No. 53. p. 25. Paris, 1811. *Bulletin de la Faculté.* 1812. *Bulletin des Sciences Méd.* II. 411. 1808. *Bibliotheque Méd.* LIII. 68. LIV. 343. *Lond. Med. and Phys. Jour.* LIII. 96. FANCONNEAU-DUFRESNE, *Thèse* No. 220. p. 25. Paris, 1824. *Recueil de Méd Militaire.* XXII. 329. ERHARDT, *Loc. Cit.* 22. JOSEPH FRANK. *Prax. Med.* Vol. II. part 2. p. 336. *Medico-Chirurg. Transact.* II. 244. BERTIN and BOUILLAUD, *Op. Cit.* Obs. XL. p. 110. LAENNEC. *Auscult. Mediat.* II. 204. RUST'S *Magazin.* XXII. 447. HUGUIER. *Arch. Gén.* Fev. 1834. PORTER. *Dublin Journ. Med. and Chem. Sc.* IV. 209. WRIGHT. *Americ. Journ. Med. Sc.* IV. 345. SAMUEL COOPER. *Medico-Chirurgical Transact.* XVI.) In this latter case, the aneurismal tumour pointed under the left scapula, but afterwards burst into the œsophagus, and several pounds of blood were passed by vomiting and stool. The individual nevertheless survived nearly two months, in the pursuit of an active employment, the rupture being, during that period, plugged up by a fibrinous concretion. Such cases are nevertheless almost always immediately fatal, blood being discharged copiously by vomiting, and the stomach is found distended with it after death.

Aneurismal tumours affecting the ascending portion of the aorta, or the concavity of the arch, occasionally contract intimate adhesions either with the trunk of the pulmonary artery, or one of its principal branches. Under such circumstances, the intermediate walls may be destroyed by absorption or ulcerative inflammation, and establish a direct communication between the two vessels. Such an accident would be apt to occasion symptoms analogous to those which arise from the admixture of venous and arterial blood, where the foramen ovale or ductus arteriosus remain pervious. The only cases of this kind of which we have any knowledge, are those reported by WELLS, *Transact. of a Societ. for the improvement of Med. and Chir. Knowledge.* III. 85. SUE, *Journ. de Méd.* XXIV. 124. PAYEN and ZEINK, *Bulletin de la Facult. de Méd.* No. 3. 1819., and NANNONI, *Trattato di Chirurgia.* II. Obs. 74.

Compression and obliteration of the vena cava have been already mentioned, as occasional consequences of aneurism of the ascending aorta. In some rare instances, extensive adhesions form between the sac and this vessel, and a communication may finally take place between the artery and the vein. In such cases, should death not immediately ensue, more or less admixture of the venous and arterial blood is apt to occur, and even a varicose condition of the vena cava may be developed, in consequence of its walls being distended by the impulse of the arterial blood. In the case observed by BEEVOR, to which reference has already been made, there was a rent of the coats of the vena cava immediately above the impervious point, which led directly into the aorta. The azygos on the one side, and the left subclavian, and a large pericardiac vein on the other, emptied themselves just above the obstruction; but they were so dilated, especially the azygos and the pericardiac, that no doubt arose as to their having been the principal channels, through which the blood of the upper half of the body found its exit into the right auricle. At the entrance of the left subclavian, there was another, and a larger rent, leading also into the aorta, thus constituting a second communication between the arterial and venous system. (*Lancet.* II. 63. 1833.) In the same work, an analogous case is reported, which occurred at St. Bartholomew's hospital. The countenance had been œdematous and purple, and the small superficial veins of the chest turgid and almost varicose. The superior vena cava contained a coagulum of blood; and about two inches above its entrance into the auricle, there was found a round opening, communicating with the aneurismal sac. (*Op. Cit.* p. 667.) A very interesting case has likewise been reported by SYME, in which a large aneurismal tumour, which occupied the abdominal aorta in the vicinity of its bifurcation, adhered to the corresponding portion of the vena cava, and communicated with that vessel, by an opening of the size of a six-pence. The individual was affected with violent pulsations in the part, coldness of the lower extremities, and œdema. (*Edinb. Medical and Surg. Journ.* and *Revue Méd.* I. 456. 1833.)

A communication may also be established between the arterial and venous circulation, in cases of aneurism of the aorta, by the tumour bursting into the right auri-

cle of the heart. Such a termination, however, must be exceedingly rare, and the only example that has been reported, so far as we recollect, is one which was observed by BEAUCHENE. (*Bulletin de la Facult. de Méd.* No. 3. 1810. *Dict. de Méd.* Nouv. ed. III. 409.)

The surface of the aneurismal sac sometimes becomes closely adherent with the corresponding portion of one of the lungs, and by encroaching upon it, occasions considerable atrophy of its substance, or under the progressive ravages of ulcerative absorption, the contents of the tumour find their way into the bronchial ramifications, and give rise to a fatal hemoptysis. Such a rupture may take place either into the right or left lung, but it is more liable to occur in the latter, because of its closer proximity with the descending aorta. MARCHETTIS met with a singular case of this kind. The right lung was so far destroyed that its place was represented by a membranous sac merely, formed chiefly by a large aneurismal tumour which had protruded into the lung. (*Obs.* 48. p. 94.) Other examples of the termination of aneurism of the aorta, by the tumour bursting into the lung, have been reported by PALLETTA, *Exercit. Path.* II. 215. Mediolani, 1820. LAENNEC, *Op. Cit.* 427. BOUILLAUD, *Dict. de Méd. et de Chirurg. Prat.* II. 405. MELHUISH, *Lancet*, I. 222. 1831. NÉLATON, *Revue Méd.* III. 58. 1833.

The ravages inflicted by the tumour on the vertebræ, ribs, sternum. and clavicle, have been already mentioned. The sternum especially is in some cases completely perforated, and the integuments, which are at first protruded before the tumour, finally give way, and the individual is destroyed by a sudden gush of blood. The same thing happens when the aneurism protrudes upward into the neck, or anteriorly and laterally, between the ribs. The bodies of the vertebra are sometimes so far destroyed, as to lay open the spinal canal; and a case is reported by MERIADEC LAENNEC, in which an aneurismal tumour of the aorta, terminated by bursting into this cavity. (*Revue Méd.* July, 1825.) The subject of the case was affected with paraplegia, during the last six hours of his life. An example of a similar kind was observed by SALOMAN. (*Petersb. Abhandl.* 1825. p. 164.)

Aneurism of the abdominal aorta, when its coats become too feeble to sustain the force of the circulation, generally bursts into the cavity of the peritoneum. Sometimes, however, the blood is extravasated behind that membrane; and occasionally, the tumour protrudes outwards, between the lower ribs and the crista of the ilium, and if the individual should survive long enough, it may finally destroy the integuments, and burst externally. The sac, in this situation, is not so apt to open into the hollow organs, as in the thorax, yet such a termination has been observed in a few instances. NANNONI reports one, in which the tumour opened into the stomach. (*Trattato di Chirurgia.* II. Obs. 87.) COMSTOCK has published a case, in which the aneurism burst into the sigmoid flexure of the colon, (*Philad. Journal of Med. and Phys. Sc.* XIII. 319.), and we think an instance is mentioned by Sir A. COOPER, where the tumour formed a communication with the jejunum. JOSEPH FRANK, moreover, speaks of a rupture into the duodenum, (*Op. Cit.* 339.) and a case is recorded by MORGAGNI, in which an abdominal aneurism burst into the cavity of the thorax.

In a large majority of cases, rupture of an aneurism of the aorta is speedily followed by death. This event generally ensues most promptly, when the tumour opens into one of the natural cavities, or a hollow organ, and especially when it takes place through the skin. When the rupture takes place into the pericardium, or the pleura, independently of the effects of the sudden loss of blood, the heart and lungs may be overpowered by the sudden extravasation of that fluid upon their surface. Suffocation, moreover, may be induced by the bursting of an aneurism into the trachea, bronchi, or lungs. But when the sac gives way, and extravasates the blood into the adjacent cellular tissue, the result is not generally so formidable. The aneurism only becomes diffused, after having been before circumscribed, and some time may elapse before a fatal termination takes place, by the yielding of the parts into which the blood is extravasated. Even when the sac forms a communication with a hollow organ, if the rent be small or oblique in its course, the case does not always terminate fatally at the time; but life may be prolonged, for a considerable period, by the aperture becoming closed by a coagulum. This event is often favoured by the occurrence of syncope at the time the rupture of the aneurism takes place, during the continuance of which a firm coagulum may form, and completely close up the breach made in the wall of the sac. It may happen, moreover, when the tumour is very large, and is occupied by considerable masses of coagula of a concentric lamellated arrangement, that the rent may range

in an oblique or tortuous direction through them, and render it more difficult for the blood to escape, while the formation of a coagulum will be greatly facilitated. In the case referred to above, which was reported by S. Cooper, the individual survived nearly two months after the aneurism established a communication with the œsophagus; a plug having formed in the solution of continuity, by which the blood was prevented from escaping into the gullet. Instances of a similar kind have been observed by others, where life was protracted for a shorter period by an analagous condition of the parts.

The fatal issue of aortal aneurism does not always depend upon a rupture of the sac. It may be occasioned by the influence of the tumour upon other organs, either adjacent or remote; and the effects upon which the fatal consequences depend, may arise either from a simple functional embarrassment, resulting from the pressure of the diseased mass, or from extensive changes of texture, excited by its presence. The individual may be destroyed by suffocation, from obstructed breathing; by inanition, from closure of the thoracic duct; by serous effusions into the cavities, apoplexy, paralysis, or a gradual impairment of the powers of life, taking place in consequence of the imperfect exercise of the functions.

D. *Causes.* The causes which give rise to aneurism have been so fully considered in the article which treats of that subject, that it will be unnecessary to describe them particularly in this place. Still it will be proper to notice those which tend more particularly to give rise to aneurism of the aorta, since this vessel, from its great magnitude, and its close relations with the heart, is liable to be acted on by influences from which other arteries are, to a certain extent, exempt.

Sex and age may be enumerated among the predisposing causes of the disease. It has been found that males are much more liable to aneurism than females; a liability which is clearly referable, in part at least, to the active physical exertion required in their laborious avocations and ordinary habits. Hodgson remarks, that out of sixty-three cases of aneurism observed by him, fifty-six were in males, and only seven in females. This disproportion, however, is probably greater than will be found to exist generally; and it is stated by Joseph Frank, that of the cases of aneurism which had fallen under his observation, about one-fourth were in females. (*Prax. Med. Univ. Precept.* II. part 2. p. 340.) The disease seldom takes place during the early periods of life, nor does it very often occur in advanced age; and when it is observed in old persons, it will generally be found to have been of long standing. (Frank. *loc. cit.*) It is most apt to occur between the ages of thirty and fifty, and manifests a predilection for individuals of a full and plethoric habit, especially when there is appended to this a gouty diathesis. There are likewise many occupations which predispose to aneurism of the aorta; and this is especially true of those which require a constant stooping position of the body, or violent corporeal exertion. Joseph Frank remarks, that he had observed nine cases of aneurism in laundresses, which he imputes to the nature of their employment. Scrofula, syphilis, rheumatism, protracted attacks of malignant fever, the imprudent use of mercury, habitual intemperance—in short, whatever has a tendency to give rise to a diseased condition of the coats of the artery, may act as predisposing causes of aneurism. Active hypertrophy of the left ventricle of the heart, or any cause giving rise to continuous or often repeated acceleration of the aortal circulation, may, after some time, occasion such changes of the structure of the vessel, as to create a liability to the disease. It should, nevertheless, be remarked, that before these causes can give rise to aneurism, they must affect some change of texture in the coats of the artery, rendering them less resistant, and disposed to become distended or ruptured, under the influence of the lateral impulse of the blood. While the structures maintain their integrity, the physical influences to which they are exposed are inadequate to give rise to aneurism; and it is only after their natural elasticity and cohesiveness have been impaired or destroyed by previous disease, that such an event can ensue. Whatever the remote predisposing cause may be, the immediate predisposition is a softening, friability, degenerescence, or ulceration of the coats of the artery, either resulting from aortal inflammation, or at least from some modification of nutrition, affecting the coats of the aorta, by which they are rendered too feeble to sustain the onus of the circulation. The manner in which these causes operate in producing aneurism, has been explained in the article *Aneurism*, already referred to, and under the section which treats of chronic aortitis, and need not now be considered.

The exciting causes are whatever is calculated to accelerate the circulation, or throw a sudden and preternatural onus on

the vessels: as, violent passions and emotions of the mind; active bodily exertion; falls, blows, and contusions; vomiting, straining at stool, the efforts of parturition, violent exertion of the lungs, excessive venereal indulgence, &c. The extreme liability of prostitutes to aneurism of the aorta, was long since noticed by Morgagni, (*Epist.* XVI. 13.) and the correctness of the remark has been since confirmed by Testa and Joseph Frank.

E. *Symptoms and Diagnosis.* In analyzing the symptoms of aneurism of the aorta, with a view to the formation of a correct diagnosis, it will be convenient to divide them into general or rational; and physical, or such as are revealed by exploration with the hand and auscultation.

a. *General Symptoms.* They are chiefly such as arise from the pressure or distension exercised by the aneurismal tumour on the parts situated in its vicinity. The organs and structures which are liable to be thus affected have been enumerated above; and the remarks there made will very naturally suggest the most striking functional disturbance which will be apt to arise from such causes. But, as most of these effects are owing to the mechanical influence of the tumour, it is evident that they must be entirely absent during the early stage of the disease, and will only make their appearance after the latter has attained considerable size. Hence there are no general symptoms that can indicate the existence of aneurism of the aorta during the first stages of its development; and daily experience demonstrates, that the disease may pass through all its stadia, attain even a great volume, and finally terminate by rupture into the cavity of the thorax or abdomen, or some of the organs, without giving rise, at any time, to sufficient disturbance to awaken even a momentary suspicion of the existing mischief. Very generally, however, more or less embarrassment of function will be experienced in those organs which suffer from the encroachments of the tumour. When the trachea or bronchi are compressed, the respiration will generally be difficult, sometimes stridulous; and where the tube is considerably narrowed, the voice may be materially modified: in one case, observed by Renaud, a species of egophonism was perceived. (*Journ. Hebdomad.* II. 3.) There is often, under such circumstances, a peculiar roughness or hoarseness of the voice, or even partial or complete aphonia. Frank relates a case of a young man at Wilna, in whom the voice was completely extinct, and who suffered so much from a sense of suffocation, that he made signs, with his hand, to his attendants to open a vein in the arm. This hoarseness and extinction of voice may arise either from the pressure of the tumour upon the air passages, or its encroachment upon the recurrent nerves. (Bourdon.) It is even possible for one of the bronchi to be thus obstructed by an aneurismal tumour of the aorta, without producing the slightest modification of the phenomena, elicited by percussion, in the corresponding lung. Auscultation, however, will discover a remarkable feebleness or total extinction of the respiratory murmur in the affected organ. But this circumstance will be insufficient to demonstrate the existence of aneurism; for the same phenomena may be produced by many other causes: as the compression of tumours of a different kind upon the bronchus, a contraction of its calibre by changes of structure taking place within its substance, or even by spasm of its ramifications. Andral reports a case, in which the right bronchus was so nearly closed by a thickening of its lining membrane, that it was scarcely capable of admitting an ordinary probe. The same difficulty of breathing and absence of the respiratory murmur may be produced by the encroachment of the aneurismal tumour upon one or both lungs.

But while all these symptoms may be developed by aneurism of the aorta, they may arise from an infinity of other causes. Hence, taken either individually or collectively, they are altogether fallacious, and furnish no positive indication of the existence of that disease.

The dysphagia which arises from the pressure of the tumour upon the œsophagus, the pain and sense of laceration sometimes experienced behind the upper part of the sternum, and which have been supposed to depend upon the forcible stretching of the nerves, and the peculiar whispering voice mentioned by Corvisart as one of the indications of aneurism, are not entitled to more confidence as diagnostic symptoms. They may be produced by so many other conditions, that no reliance can be placed on them, except when they are accompanied by other phenomena of a more positive character.

The effects which arise from the pressure of the tumour upon the vena cava may be enumerated amongst the symptoms of aortal aneurism. It has been remarked above, that in the cases observed by Corvisart and Renaud, there were symptoms of cerebral congestion even

apoplectic in their nature, together with an œdematous condition about the face and neck. In Renaud's case, in which the vena cava was obliterated, the superficial veins were turgid, and the blood was returned to the auricle through the anastomosis between those of the thorax, and the superficial veins of the abdomen. The same, or similar phenomena were observed in the cases reported by Syme, and Beevor, and in that which occurred in St. Bartholomew's Hospital. It is remarked in Beevor's case, that the veins over the chest were exceedingly turgid and in "a varicose condition;" and in the case at St. Bartholomew's, "clusters of minute veins, almost varicose, were scattered over the chest; and on the back, in addition, there were several large cutaneous veins." To these symptoms, may be added preternatural venous pulsation in the neck, to which several writers on this subject have made particular reference. It will always exist where there is a communication between the aneurism and the vena cava; but may likewise be produced by the impulse of the former being imparted to the veins. Still these symptoms, like the preceding, may depend upon disease of the heart, and other conditions, and can never be regarded as affording conclusive evidence of the existence of aneurism.

It has been remarked by Corvisart, that extreme smallness and irregularity of the pulse, its inequality in the two arms, or its extinction in one of them, may be regarded as indications of aneurism about the arch of the aorta. It is true that these peculiarities of the pulse often exist, yet they are perhaps as often dependent upon diseases of the heart, or other pathological conditions, and are, therefore, in themselves, entitled to but little confidence. A similar remark may be made in relation to the dull or lancinating pains which are sometimes experienced behind the sternum; pain and numbness of the shoulder and upper extremity, which sometimes arise from the pressure of the tumour on the lower part of the axillary plexus of nerves; violent pulsation of the carotid and temporal arteries; vertigo; disposition to syncope or exhaustion on taking slight exercise; obfuscation of vision; ringing of the ears; wakefulness; convulsive motion of the muscles of the face and extremities; obstinate cough; mucous and bloody expectoration; epistaxis; hemoptysis; and a hundred other symptoms which have been enumerated by Joseph Frank and other writers. That gentleman, indeed, states, that his description of the symptoms of aneurism of the aorta was drawn from a hundred and thirty-seven cases observed by himself, and nearly as many described by others; and it may be very well remarked, that there is scarcely a symptom of any disease of the thoracic organs, which he has not included in the list.

When the aneurism occupies the thoracic aorta, other symptoms are often appended. There is frequently pain of the back, which is sometimes dull, sometimes more or less acute; and when important changes have taken place in the bodies of the vertebræ in consequence of the encroachment of the tumour, the pain is often of a boring or lancinating character. There is also sometimes a painful sense of constriction ranging round the inferior part of the thorax, in the direction of the attachments of the diaphragm; and in some instances, the pain and uneasiness are so strikingly manifested about the epigastric or hypochondriac regions, that the disease is liable to be mistaken for an affection of the stomach or liver. Through the kindness of our friend, Dr. Thomas, we had an opportunity of examining a case of this kind within a few months. The individual was a stout negro man, who for a year or two previous to his death had complained of occasional uneasiness in the right hypochondriac region, and had been treated by a skilful physician for a chronic affection of the liver. At the period of his death, he had just been engaged in splitting wood in a cellar, and dropped down suddenly without any premonition. The left cavity of the pleura was found distended with coagulated blood, which proceeded from the rupture of a large aneurism of the thoracic aorta situated immediately above the diaphragm, to the tendinous portion of which the tumour was intimately attached. Indeed, aneurism of the aorta, like some of the diseases of the heart, not unfrequently occasions considerable congestion and enlargement of the liver and spleen, or both, and when the tumour is voluminous, it may protrude the diaphragm downwards, and with it the organs in question, to such an extent, as to force them considerably out of their natural situation. The liver may even present, when explored through the walls of the abdomen, all the indications of extreme enlargement, yet retain its natural volume, the deception being occasioned by its being forced forward, downward, or laterally, by a large aneurismal tumour. Dr. Beatty has described a very interesting case of this kind, in which, for some time before

death, the liver appeared distinctly enlarged, and the tumefaction seemed to increase daily in size. Death was occasioned by the rupture of a large aneurismal tumour of the aorta into the cavity of the pleura. On proceeding to examine the body, it was found that the apparent tumefaction of the liver had disappeared, and that that organ, with the exception of a few indentations upon its convex face, occasioned by the pressure of the ribs, was healthy. The collapse of the aneurismal tumour allowed the liver to resume its natural situation, and of course the semblance of enlargement was no longer perceptible. (*Dublin Hospital Reports.* V.)

So soon as the tumour attains sufficient size to protrude from the cavity of the thorax, or to deform and destroy the walls of that cavity, there can no longer be any difficulty in recognizing the nature of the disease. This means of diagnosis, however, is only applicable in a few cases; for in a large majority of instances, the tumour ruptures, or the disease terminates fatally in some other way, long before its development advances so far.

It will thus be seen, from a review of the general symptoms of aneurism of the aorta, that they are all such as are common to many other diseases. However well calculated they may be, when taken collectively, and in connexion with the circumstances of the case, to awaken a suspicion of the existence of aneurism, they can never afford more than presumptive evidence, and are altogether too equivocal without the corroborative indications to be drawn from other sources, to warrant a positive conclusion. In conjunction with other phenomena, however, some of them may occasionally afford considerable assistance in arriving at a correct diagnosis.

b. *Physical Signs.* Preternatural pulsation behind the sternum, in the lower part of the neck, in the carotid arteries, and in the course of the abdominal aorta, though not strictly physical signs, may be enumerated under this head. It is a common attendant upon aneurism, and varies as to its precise situation and other circumstances, according to the location of the disease, and the condition of the adjacent parts. In itself, it is always an equivocal symptom, as it may be occasioned by a disease of the heart, by tumours encroaching upon the aorta, by an extreme state of nervous erethism of that vessel or of the vascular system generally, by inflammation and adhesions of the pericardium, or even a solidification of the lungs and other thoracic organs. It is a common symptom in extreme anemic states of the system; and in some cases of that disease we have seen it so strongly manifested, that an inexperienced observer would have been very liable to suspect the existence of aneurism. Aneurisms of the innominata, and of the subclavian and carotid arteries, when they are situated low down, are likewise attended with a similar pulsation; and Burns, Cooper, Hodgson, and others, long since pointed out the difficulty which is often experienced in distinguishing them from aneurism of the arch of the aorta. Still, if with violent pulsation behind the upper part of the sternum, and other symptoms of aneurism, there be associated, the smallness, irregularity, and inequality of the radial pulses above alluded to;—or if with a similar pulsation in the course of the abdominal aorta, there be analogous character in the pulses of the femoral arteries, some grounds will exist for suspecting the disease to be aneurism; but additional evidence will be necessary to justify a positive conclusion. But while this is true of mere increased pulsation, we shall presently see, that when the character of the impulse, and the sounds of the artery, are accurately analyzed, they are capable of affording valuable indications.

Dullness elicited by percussion in the upper part of the chest, though a common symptom in thoracic aneurism, is not peculiar to that disease. A purring tremor, perceptible when the hand is applied to the middle or upper part of the sternum, has been mentioned by Corvisart as an evidence of the existence of aneurism of the descending aorta. Elliotson likewise remarks, "that a bellows-sound, or a thrilling sensation given to the hand only, or chiefly, when applied *above* or to the right side of the cardiac region, may justly give a strong suspicion of the disease. But neither of these symptoms always occurs; and both were absent in four cases out of seven." (*Art of distinguishing the various diseases of the Heart*, &c. p. 35.) Laennec even affirms, that he had not been able to distinguish the purring tremor before the aneurism became manifest externally; and a similar remark is made by Hope, who represents, that he had never found it perceptible below the clavicle, except where the enlargement was so great as to extend beyond the lateral margins of the sternum, and allow the tremor to be felt through the intercostal spaces; or where a sacculated aneurism had eroded the bones and presented be-

neath the integuments. (*Treatise on diseases of the Heart*, &c. p. 417.) Even when present, it is an ambiguous symptom. It may depend upon simple dilatation of the vessel; mucous rhonchus in the bronchi; ossification of the valves of the heart; or even a rugged and uneven condition of the inner surface of the aorta, especially when the circulation is much accelerated.

Auscultation furnishes decidedly the strongest,—indeed we may say, almost the only positive indications of aneurism of the aorta. Laennec, who did not consider the stethoscope adequate to form a diagnosis in this disease, remarked, nevertheless, that he had sometimes succeeded in detecting its existence by means of that instrument. The phenomenon to which he attached the greatest importance was, "a single impulse in the situation of the tumour, louder and more forcible than that of the ventricle, and synchronous with the pulse." This single impulse can generally be distinguished from that of the heart, which is double, or consists of a short and a prolonged sound, the first of which Laennec attributed to the auricle, and the second to the ventricle. The latter only is synchronous with the pulse, and as the auricular sound cannot be generally heard in aneurism, the ventricular sound is the only one liable to be confounded with that occasioned by the aneurismal tumour. The latter, however, can be distinguished from it, by its greater intensity, as well as by its harshness and other characters. Laennec questioned the sufficiency of this means of diagnosis, except in a limited range of cases. As the impulse and sound of the heart is generally diffused over the whole of the substernal, and even the entire subclavicular regions, whenever the cavities of the organ are dilated, he supposed that under such circumstances, the diffused ventricular impulse might be confounded with the impulse of an aortal aneurism, while the feebler auricular impulse or sound, being extended as far as the aneurism, might be mistaken for the impulse of the tumour. It should be mentioned, moreover, that the aneurism may, under particular circumstances, acquire a double stroke or impulse. This will take place whenever the tumour comes in contact with either the heart or the surface of the pericardium; or whenever a solid tumour or other firm medium is interposed between the heart and the aneurismal sac, by which the impulse of the former may be transmitted to the latter. Cases illustrative of these phenomena have been observed by Graves and Stokes, and Cruveilhier. It is indeed represented by Stokes, that the tumour may present a double stroke without any contact, either direct or indirect, with the heart.

The possibility of deception from the causes enumerated, renders it necessary that great caution should be observed in exploring the chest. If this be attended to, we are inclined to think with Hope, that "it is unimportant whether the pulsations be *simple* or *double*, for, though double, they may be distinguished from the beating of the heart, by unequivocal criteria." He remarks, that the first or aneurismal sound coinciding with the pulse, is invariably louder than the healthy ventricular sound, and generally than the most considerable bellows-murmurs of the ventricles; that in exploring the aneurismal sound from its source towards the region of the heart, it is found to decrease progressively, until it becomes totally inaudible, or is lost in the predominance of the ventricular sound; that if the sound emanated from the heart alone, it would increase, instead of decreasing, on approaching the præcordial region:—that the second sound actually does sustain this progressive augmentation on advancing towards the heart; and as its nature and rhythm are found to be precisely similar to those of the ventricular diastole heard in the præcordial region, it is distinctly identified as the diastolic sound. Hence the second sound corroborates, rather than invalidates the evidence of aneurism afforded by the first; for if both sounds proceeded from the heart, both would, on approaching it, or receding from it, sustain the same progressive changes of intensity:—finally, that the aneurismal pulsation is a deep hoarse tone, of short duration, with an abrupt commencement and termination, and generally louder than the most considerable bellows-murmur of the heart. It accurately resembles the rasping of a sounding-board heard from a distance; whereas, the sound occasioned by valvular disease of the heart has more analogy to the bellows-murmur, being somewhat soft and prolonged, with a gradual swell and fall. (*Loc. Cit.* 425.)

These characters will be observed either beneath the sternum or in the dorsal region, in thoracic aneurisms. When the disease affects the ascending aorta, or the arch, the sounds will be perceptible in the upper portion of the thorax, above or on the right side of the cardiac region; but when it occupies the descending portion

of the vessel, the strong single impulse and sound will be most manifest in the back. As the natural impulse of the heart is always feeble in this region, it cannot be well mistaken for the sound occasioned by aneurism, especially if the latter present the abrupt, hoarse, or rasping character, which generally attends it.

It may be proper to observe, that even the sound of the aneurism itself may be double; so that when the stethoscope is applied, a distinct double bellows sound (*Bruit de Soufflet*) can sometimes be heard in the situation of the aneurismal tumour,—the first of which is synchronous with the pulse; while the second, which is louder, takes place during the disastole of the ventricle, and is occasioned, according to Elliotson, by a recoil of the dilated portion of the vessel upon the blood, and the consequent propulsion of this fluid into the narrow portion of the vessel beyond the tumour. (*Loc. Cit.* p. 35.) The first sound, he thinks, proceeds, in like manner, from the column of blood pressing from the dilated into the narrow portion of the vessel, under the influence of the impulse communicated to it by the systole of the ventricle. The bellows sound does not, therefore, depend upon spasmodic or irregular action of the vessel, as supposed by Laennec, but upon the state of its calibre and the condition of its tunics. But, while the explanation offered by Elliotson may be true in some cases, there are others in which the bellows-murmur seems to proceed from a different cause. Thus it has been ascertained by Corrigan, that in some cases of aortal aneurism, this sound does not exist as long as the body is erect, or in a position to keep the aneurismal sac as forcibly distended by the column of blood as the aorta itself; but becomes very manifest and distinct as soon as this pressure is removed from the walls of the tumour, by placing the individual, for a few minutes, in a recumbent position. This fact, which he had repeatedly occasion to verify, he explains upon the supposition, that so soon as the walls of the sac are relieved from the active distention occasioned by the lateral pressure of the column of blood, this fluid, in rushing into it, will form diverging currents, which will strike against the parietes, and excite vibrations, presenting all the characters of the bellows' murmur, or the purring tremor adverted to above. (Corrigan. *Dublin Journ. of Med. and Chem. Sc.* II. 375.) In some cases, however, when the sac is large, its walls thickened, or its cavity filled up by extensive masses of coagula, both the bellows-sound and the purring tremor may be absent, and cannot be observed under any position or condition of the body. We think, however, that there are but few cases in which a correct diagnosis may not be formed, by an observance of the indications detailed above.

These observations of Corrigan are particularly important in relation to the diagnosis of abdominal aneurisms; for there the pressure of the column of blood being the greatest, it will be the more necessary to place the patient in the horizontal posture, in order to render the bellows-sound of an aneurism perceptible. Fortunately the disease can generally be distinguished, in this region, by strong pulsations, which present the peculiar thrill of aneurism, and by other characters which are unequivocal, even though unassociated with any indications of the bellows-sound. Still, it must not be forgotten, that tumours within the abdomen, either reposing upon the aorta, or interposed between it and the surface, may often become a medium, through which the pulsations of the vessel may be transmitted with so much force, either to the ear or the hand, that an abdominal aneurism might be suspected where none exists. These tumours, however, are destitute of both the purring thrill and the bellows-murmur. Nervous pulsations of the abdominal aorta may be easily distinguished from aneurism, by their being diffused along the whole extent of the vessel; while the pulsation of an aneurism is greatest at some one point.

E. *Spontaneous Cure, and Medical Treatment.* As rules for the treatment of aneurism can be most advantageously deduced from an analysis of the various steps adopted by nature, in accomplishing a spontaneous cure of the disease, it would be proper here to enter upon such an analysis, were it not that the subject has been already discussed in the article *Aneurism*, and in some of the preceding sections of the present article. It may, nevertheless, be proper to remark, that one of the first steps concerned in the accomplishment of this salutary result, is the formation of a coagulum within the aneurismal sac, which attaches itself to its inner surface. This is facilitated by cracks and fissures of the lining membrane, or by a preternatural roughness of the inner surface of the diluted vessel, which tends to retard or entangle the blood, and promote its coagulation; and the process once commenced, it may continue until the whole tumour, or the entire calibre of the vessel, is completely obliterated,—the circulation gradu-

ally finding its way through the collateral vessels. Several cases of this kind have been referred to under the section on obstruction and obliteration of the aorta; and we have previously remarked, that it has been rendered probable by Hodgson, that sacculated aneurisms of the aorta may undergo a spontaneous cure, even without obliteration of the vessel taking place. He thinks the sac may become gradually filled up by lamellated coagula, so as to preclude the further ingress of the blood from the vessel; and that, in course of time, it will become contracted into a firm tumour, destitute of cavity, merely adhering to one side of the artery. In all cases of spontaneous cure, however, there is besides simple coagulation of the blood within the tumour, lymph deposited upon the surface of the sac, and in the midst of the tissues forming its walls, which, in becoming organized, constitutes one of the most important means in the accomplishment of the cure.

Coagulation, within the aneurismal tumour, constituting, therefore, one of the first and most important means adopted by nature, in effecting a spontaneous cure of aneurism, the artificial means resorted to, with the same object, should be, as far as practicable, of a character to produce the same effect. This indication can be best fulfilled by such remedies as are most competent to diminish the velocity of the circulation, without impairing the plastic properties of the blood, or undermining the powers of the system. Unfortunately the one object cannot be accomplished, except at the risk of inducing the very condition we are anxious to avoid; for, although we possess in blood-letting, diet, &c. ample means for the fulfilment of the first part of the indication, their effects lead necessarily to such a diminution of the coagulability of the blood, and to so serious an impairment of the vital powers, as to defeat, in a great degree, the end we have in view.

It has, nevertheless, been long the practice to treat internal aneurism by a most rigid and protracted antiphlogistic course. This practice, which was first introduced by Albertini and Valsalva, still has many adherents, although there are likewise many who have pointed out its abuses, and the mischievous consequences which sometimes arise from its improper application. Valsalva was in the habit of confining his patients constantly to the recumbent posture, and reducing them so low, by repeated abstractions of blood, that they were unable to raise their hands from the bed. We are informed by Morgagni, (*Epist.* XVII. 30.) that after Valsalva had drawn the requisite quantity of blood, he reduced the food from day to day, until he brought it as low as half a pound of meal pudding or pap, in the morning, and half that quantity for the evening; with nothing else but water, in very small quantities, containing, in solution, a little quince jelly, with powdered carbonate of lime. When the individual had been reduced to a helpless condition by this procedure, the quantity of aliment was increased by degrees, until he took the amount to which he had been accustomed.

This practice is no doubt beneficial when circumscribed within reasonable limits; but, when carried to the extent here represented, we have no hesitation in affirming, that it would very generally prove highly mischievous. It is desirable to moderate the activity of the circulation, as far as is consistent with safety, because, in proportion as we do so, the formation of coagula, within the aneurism, will be promoted. The effects, however, of inordinate blood-letting, and of too severe a diet, it must always be remembered, will be to give rise to consequences diametrically opposite to what we wish to obtain. When depletion is carried too far, it awakens a kind of convulsive turmoil in the organs of circulation, which would be altogether incompatible with the development of those changes by which an aneurism can be cured; and besides, under such a course of treatment, the blood is deprived of its fibrinous properties, becomes exceedingly thin and watery, and is consequently less capable of coagulating than under other states of the system.

The first thing to be considered, in instituting a plan of treatment for aortal aneurism, is the constitution of the individual. If it be feeble, and broken down by previous disease, copious and repeated detractions of blood will be inadmissible, inasmuch as a resort to them could scarcely fail to lead to fatal consequences. But, when the patient is more plethoric and robust, and has not had his constitutional powers seriously impaired, blood may be more freely drawn, and the operation repeated from day to day, until it has been carried as far as may be compatible with safety, and the effects which are required. Hope remarks, that he has found "the best effect to be produced with the least expenditure of blood, by drawing from xx. to xxv. ozs. in the first instance, and repeating the bleeding to x. or xv. ounces

within twelve hours; and then taking vi. or viii. ozs. every six or eight hours, or at such intervals as to prevent the re-establishment of reaction,—a phenomenon which, by producing an inordinate energy of the circulation, counteracts the effect of the depletion." (*Loc. Cit.* 448.)

While we are willing that such a course should be adopted as a general rule, especially in those whose constitutional powers have not been seriously impaired, we feel assured, that in a large proportion of cases, blood must be more sparingly drawn, if we would not jeopard the life of the patient. There is, indeed, abundance of evidence to prove, that too much depletion, and too severe a regimen, will often thwart the fulfilment of the very objects we have in view. The bad effects may, as previously remarked, either consist in the impairment of the plastic or cohesive powers of the blood, by depriving it of its fibrine,—in the development of that peculiar preternatural throbbing of the vascular system, which is so wont to supervene upon copious abstractions of blood; and finally, an enfeebling of the cohesiveness of the coats of the artery, rendering them more friable, and consequently more prone to rupture under the distending influence of the blood. The truth of the last inference has been fully confirmed by the extensive experience of Dupuytren, who has repeatedly remarked, that internal aneurisms, treated by Valsalva's method, are apt to increase more rapidly in size, and finally rupture,—consequences which he explains upon the supposition, that the depletion weakens the coats of the arteries more than it does the action of the heart. (Paillard. *Revue Médicale*, Jan. 1829.) In the case reported by Beatty, already referred to,—in one published by Proudfoot, in the Edinburgh Medical and Surgical Journal, and in others observed by Stokes and Graves, (*Dublin Journal.* V. 431.), a manifest amelioration of the disease was produced by a change from a very scant, to a more generous diet. Still this change should never be made, except where it is absolutely demanded by the prostration of the vital powers, either induced by disease, or by previous depletion and abstinence; and even then, it must be done gradually, and in such manner as not to excite the heart and arteries, by rendering the blood suddenly too rich in plastic and stimulating properties.

As regards the method of drawing blood, there is some difference of opinion. Morgagni long since cautioned against bleeding to syncope, in cases of internal aneurism, representing that death sometimes takes place; and Hodgson, adopting similar views, (in which he is followed by Bertin and Bouillaud, Hope, and others,) remarks, that he has seen the syncope protracted to an alarming period, and that a coagulum is apt to form in the aneurismal tumour, which, on recovery from the fainting fit, will prevent the blood from resuming its usual route, and give rise to fatal embarrassment of the circulation. Chomel, on the contrary, advises to seat the patient in an upright posture, and bleed him from a large orifice, until syncope is induced,—in order that the blood, during its quiescent state, may coagulate better in the aneurism, and thus lay the foundation for its obliteration. (*Dict. de Méd.* 2d edit. III. 418.) The propriety of this practice may be questioned; and, if the view taken by Hodgson be adopted, it cannot be considered as entirely exempt from danger. The gradual abstraction of blood will probably be found more useful, and should consequently be preferred; but even this must, in general, be cautiously resorted to, when the individual is much affected with palpitations.

When general bleeding has been pushed as far as the strength of the patient will admit, the application of leeches will often prove highly serviceable. But, when the tumour protrudes externally, and elevates the skin, they should never be applied directly to the part, on account of their liability to excite ulceration or sloughing of the skin, which might hasten the fatal termination of the disease.

On the subject of internal remedies, much need not be said. Mild saline aperients will be proper from time to time, to keep the bowels soluble and quiet irritation; and, with the latter view, together with the object of exciting the discharge by the kidneys, the nitrate or acetate of potassa, or some of the other mild saline diuretics, may be employed.

The power which digitalis possesses, in controlling the action of the heart and arteries, has led to its general employment in this disease. It is no doubt capable of doing much good, when prudently administered; but when given in large doses, or so rapidly introduced as to exercise its prostrating influence, it may prove fatal, as represented by Hope, by exciting syncope. It should, therefore, be given in very small doses, repeated at proper intervals, care being taken to observe its effects very closely. The same remarks will apply to hydrocyanic acid, prunus lauro-cerasus, colchicum, hyoscyamus, stramo-

nium, and all the kindred articles, which may sometimes be resorted to as palliatives.

Various remedies,—mostly of the astringent kind, have been employed with the object of improving the crasis of the blood, and thus rendering it more liable to coagulate. Of these, the acetate of lead is the most popular. It has been used by DUPUYTREN, LAENNEC, BERTIN and BOUILLAUD, JOSEPH FRANK, HOPE, COPLAND, and others, with some advantage. HOPE recommends it to be given in half-grain doses gradually increased to a grain, combined with half a grain of opium, three or four times a day. Its tendency to excite gastric irritation or colic, he says may be obviated by mucilaginous diluents, and an occasional dose of castor oil. The mineral acids have also been employed, but we are not aware that they have been of any service; nor is it certain that alum, or the preparations of iron recommended by KREYSIG (*Die Krankheiten des Herzens.* 2 Theil. 744.) are more entitled to confidence. COPLAND, however, remarks, that in cases attended with palpitation of the heart, or inordinate pulsation of the tumour, he has prescribed the sulphate of zinc, and the sulphate of alumina, generally combined with small doses of camphor and hyoscyamus, with considerable benefit as palliatives. (*Dict. of Pract. Med.* I. 78.)

When the tumour protrudes beyond the walls of the thorax, it has been recommended by some practitioners to apply ice, cold astringent lotions, &c., to the part. There is reason to suppose that good effects might be realized from the application of ice, if it were possible for the patient to endure it for a sufficient length of time. But generally it creates so much pain and suffering that it cannot be long continued, and its mere temporary employment can be of no great avail towards effecting a cure. When there are pain and inflammation in the tumour, however, cold and anodyne lotions may be advantageously resorted to as palliatives.

In carrying out the treatment, perfect quietude of both mind and body must be enjoined. The patient should be confined to the horizontal posture, and prohibited strictly from the use of everything which can tend in the slightest degree to accelerate the circulation. The diet should be at first altogether fluid, and as bland as possible; and when an attempt is to be made to effect a radical cure, it must be reduced in accordance with the principles already suggested. Should any amelioration be experienced under the reduction, the system should be persevered in some time longer;—but when no benefit accrues, or when the disturbance of the patient and the impairment of his health are increased by the treatment, and the dietetic regimen, they should be immediately abandoned, and the patient put upon a more generous diet.

After all, it must be confessed, that we have but slender grounds to hope for complete success in the treatment of aortal aneurisms by any system of practice. That cures have sometimes been effected spontaneously, there is too much evidence to allow us to entertain a doubt; and that some cases have been successfully combated by various modifications of the practice of VALSALVA and ALBERTINI, must likewise be granted. But if a careful analysis of all the facts and statements be made, it will probably be found, that many of the reputed cases of success have not been examples of aneurism, but of pulsation of the aorta from other causes, or glandular or other tumours developed upon the course of that vessel. True aneurism of the aorta of considerable size, is probably never obliterated, when it assumes either the fusiform or cylindroid shape; and our principal hope of success must be confined to those cases of sacculated false aneurism, which are rough and uneven upon the inner surface, and communicate with the cavity of the vessel by a narrow opening.

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Roots. *Clinical Lecture on the diagnosis and pathology of aortic aneurism.* London Med. and Surg. Journ. III. 809. (1833.)

Stokes. *Researches on the diagnosis and pathology of Aneurism.* Dublin Journ. of Med. and Chem. Sc. V. 400. (1834.)

Porter. *Cases of internal aneurism.* Ib. IV. 206. (1834.)

Breschet. *Mémoires Chirurgicaux sur différentes espèces d'anévrismes.* 4to. Paris, 1834.

Montault. *Considerations et observat. sur le siége, la marche, et la terminaison des anévrismes de l'aorte pectorale.* Lancette Française. VIII. 422. Paris, Sept. 6, 1834.

Besides these authorities, we have noted the following isolated cases, &c., which are contained in the Journals we have at hand:

New-York Medical Repository. VII. 24. Am. Med. Recorder. XIV. 239. Philadelphia Journ. Med. and Phys. Sc. XI. 414., XIII. 180. 318., X. 88. American Journ. Med. Sc. I. 200., II. 202. 451., V. 145. 487., VII. 556. 229., IV. 345., VI. 243. North American Med. and Surg. Journ. XII. 102. 104., XI. 245., X. 160., IX. 164. Johnson's Medico-Chirurgical Review. IV. 767., IV. N.S. 200., VII. 233., VIII. 559., XIII. 179. 187. 277. 280., IX. 508., XXIV. 262. Dublin Journal. II. 448. London Med. and Surg. Journal. IV. 293. 298., I. 277. 707. London Medical Gazette. II. 531. 410. for 1832–1833. Lancet. VIII. 19., III. 222., for 1830., II. 63. 666., for 1832–1833., II. 626. 888. 443. 900., for 1833–1834. Archives Générales de Médecine. I. 277., for 1833–1834. Revue Médicale. Jan. 1833., Mars 1833., I. 315. 1834., II. 110., III. 58. 1833. Gazette Médicale, for March, 1833. III. 874.

For numerous authorities and cases amongst the earlier writers, see also Ploucquet, Bibliotheca Medico-Practicæ et Chirurgicæ, &c. I. 332. Tubing. 1793.

§ 5. *Wounds of the Aorta.* In wounds penetrating the thorax and abdomen, the aorta, in common with the other organs contained within those cavities, is liable to be injured; but as such wounds are almost always immediately fatal, they

seldom become objects of surgical treatment. It sometimes happens, nevertheless, that death does not ensue so promptly; and cases have been reported, in which individuals have survived wounds inflicted upon the aorta for a considerable period. Such instances, it is true, are exceedingly rare; yet the fact that such an occurrence is possible, is important; because it indicates the necessity, when a suspicion exists that such an accident has been sustained, of employing those means which are calculated to afford the individual the best security against a fatal termination.

As a brief abstract of the most remarkable cases of wounds of the aorta has been given by BÉRARD, in an article on that subject, in the *Dict. de Méd.* III. 421., we cannot do better than present a summary of the most interesting facts which he has selected. The first is a case published by SASSARD, in the *Journal de Médecine*, XLVI. 435. In an individual who died on the sixth day of a wound of the thorax, it was found that the aorta had been wounded, a little above its exit from the left ventricle. LEROUGE has reported a case, in which death did not take place until the eleventh day, although the instrument by which the wound was inflicted, passed through both the aorta and the right auricle of the heart. (*Recueil d'Observat. Chirurg. de* SAVIARD.) A still more remarkable case is published by PELLETAN. (*Clin. Chirurg.* I. 92.) A young officer was brought to Hôtel Dieu, whose thorax had been transfixed in a duel, with a fencing foil. The weapon had entered a little above the right nipple, and came out at the left side of the breast. No accident occurred during the first fortnight; but, at the expiration of this time, he complained of pain about the kidneys, which was quieted by the bath. After this he recovered so far as to be able to walk with the other patients. But in about two months, deformity of the spine took place, the respiration became exceedingly laborious, and he died suffocated. The right side of the thorax was found full of coagulated blood, and the aorta, a little above the pillars of the diaphragm, presented an opening of the size of a writing-quill.

It is even possible for a slight wound of the aorta to be followed by the development of a false consecutive aneurism. The only recorded case of this kind is one reported by GUATTANI (*de aneurismatibus*), which occurred in a servant, who survived eight years after the receipt of the injury. The wound was inflicted by a sharp instrument, which penetrated the lumbar region, in the vicinity of the spinous processes. The principal inconvenience that was experienced, after the wound had healed, was acute pain in the loins; and when death took place, it was found that a large aneurismal sac existed upon the aorta, on a level with the cicatrix, although the coats of the artery in the vicinity presented no traces of atheromatous or calcareous degeneration.

When we reflect upon the great size of this vessel, it is manifest, that any wound not to prove immediately fatal, must be exceedingly small. Even a puncture of very limited size, transfixing its walls, will be sufficient to give rise to fatal hemorrhage; and an incised wound must necessarily prove fatal within a few moments of its infliction. It is possible here, however, as in some cases of wound of the heart, when the puncture is very small, for the opening to be closed up by a coagulum, especially if syncope should take place at the period of the infliction of the injury, and thus prove a means of protracting the fatal termination. The cases referred to above, render it not improbable that a cure might sometimes be obtained, under favourable circumstances, and by judicious treatment. Such an event, however, can seldom be expected; and even in contused and lacerated wounds of the aorta, the same unfortunate issue always takes place, because the vessel is so large that contusion and laceration do not afford the protection against hemorrhage which they often do in vessels of smaller size.

If it were possible to discover a wound of the aorta not immediately fatal, it would be proper to confine the individual for months in a perfect state of immobility, both of body and mind; to abstract blood from day to day, or at longer intervals, as far as might be compatible with safety, and to institute all those means which are proper to subdue the activity of the circulation.

BIBLIOGRAPHY.—BERARD. *Plaies de l'Aorte*, in Dictionnaire de Médecine, 2d edit. III. 422. Paris, 1833.

§ 6. *Ligature of the Aorta.* The facts which have been detailed in the section treating of obstruction and obliteration of the aorta, prove conclusively, that the closure of this great vessel does not necessarily suspend the circulation in the lower extremities. The same fact has been established by experiments which have been repeatedly made on animals; from which it appears, that in them, even a ligature may be applied to the aorta without leading to fatal consequences,—the capacity

of the collateral circulation becoming, under such circumstances, sufficiently increased to supply the members, and to compensate for the obliteration of the main trunk. The daring intrepidity of modern surgeons has even prompted them to practise this operation on the human subject; but although it has now been performed three times, the results have been such as to be far from encouraging. All the cases terminated fatally within a few hours, although the operation was achieved without difficulty.

The first operation of this kind was performed by Sir Astley Cooper, in a case of very large aneurism of the iliac artery, which sloughed and nearly destroyed the patient by hemorrhage. He first opened the aneurismal sac above Poupart's ligament, in order to ascertain if the aorta could not be secured near its bifurcation without dividing the peritoneum. Finding this impracticable, he made an incision three inches in length, along the linea alba, commencing above the umbilicus, and ranging round it, to terminate below. He then passed his finger between the convolutions of the intestines, down to the spine, where the artery was felt beating, and scratching through the peritoneum with his nail, the finger was passed beneath the vessel, and a blunt aneurismal needle armed with a ligature was conducted round it, guided by the finger. The ligature was then cautiously drawn. The patient survived the operation only forty hours, when he died apparently from exhaustion. (Cooper and Travers' *Surgical Essays.* I. 114.) Dissection revealed no peritoneal inflammation, and the temperature of the limb on the side on which the iliac artery was sound, was ninety-six after the operation.

Mr. James, of Exeter, performed the same operation in 1829, on an individual labouring under aneurism of the iliac artery, for which he had previously applied a ligature on the distal side of the tumour, according to the method of Brasdor. As the tumour threatened to burst, he resolved, as the last chance, to apply a ligature to the aorta. The operation was performed in the same manner as in the preceding case; but the individual survived only three hours and a half. (*Medico-Chir. Trans.* XVI. Pt. 1. 1830.)

The third operation was performed by Dr. Murray, at the Cape of Good Hope, on the 26th of Feb. 1834. The subject was a Portuguese seaman, aged thirty-three, of spare habit; and the circumstances of the case were analogous to those in the patients operated on by Sir A. Cooper and Mr. James—the disease being iliac aneurism. The ligature was applied immediately above the bifurcation of the aorta, and was followed by a subsidence of the temperature of the right ham to $89\frac{1}{2}°$, that of the axilla being 98°. The patient survived the operation not quite twenty-three hours. (*Lond. Med. Gazette.* p. 6. Oct. 1834.)

So far then, as the results obtained on the human subject by this formidable operation are concerned, there is but little reason to hope, that the application of a ligature to the aorta, either for the cure of aneurism, or for other purposes, can ever be successful. It has been supposed by Cooper and others, that if the operation could be performed at an earlier period, the chances of success would be very much increased. The principal difficulty seems to be the inadequacy of the collateral circulation to compensate for the obstruction of the main current through the aorta. But when it is remembered, that in the cases of spontaneous obliteration of this vessel which have been detailed above, the collateral anastomosis was found sufficiently capacious to obviate this difficulty, there would, at first sight, seem to be no reason why the same provision should not suffice, when a ligature is applied. The results of the numerous experiments made by Cooper, Beclard, Pinel Grand-Champ, and others, show conclusively, that in domestic animals the application of a ligature to the aorta can be practised with complete success, and if things were equal in them and in the human subject, the same success ought to be obtained in the latter, although the results of experience, thus far, do not seem to justify such a conclusion.

This reasoning, though apparently plausible, is far from being conclusive. In the first place, the parallel between spontaneous obliteration, and that which is produced by ligature, is not perfect. The first takes place gradually, and in proportion as the obstacle to the passage of the blood through its natural channel increases, the collateral vessels become by degrees dilated, so that by the time complete closure takes place, the numerous anastomoses formed between the internal mammary and epigastric arteries,—the intercostals, lumbars, circumflex iliac, &c., are sufficiently dilated, to furnish an adequate supply to meet the demands of the lower extremities. When a ligature is applied, on the contrary, the interruption is sudden; the collateral ves-

sels have not time to dilate, and before a sufficient quantity of blood can find its way through these numerous channels, death must take place. The experiments made on animals are not conclusive; for, independently of their collateral circulation being freer than that of man, they bear injuries with greater impunity, and possess resources which better enable them to ward off their bad effects.

From all these considerations, we think the operation in question ought never to be performed. It is certainly the duty of the surgeon to avail himself of every possible means of prolonging human life, but no circumstances can justify a resort to a painful and hazardous operation, which promises no prospect of a successful issue. With these impressions, we shall not describe the different procedures which have been devised for applying a ligature to the aorta, but merely subjoin, that it may be done either by making an incision in the course of the linea alba, as practised by Sir Astley Cooper and Mr. James, or by dividing the walls of the abdomen in the space between the margin of the ribs and the crista of the ilium, afterwards detaching the peritoneum from the psoas muscles, as was done by Dr. Murray.

§ 7. *Rupture of the Aorta.* In speaking of the pathological characters of chronic aortitis, it was remarked, that the effect of that disease is sometimes to give rise to such a friability, softness, or degeneration of the coats of the aorta, as to predispose them to terminate in rupture of that vessel. This termination is common in aneurism, but occasionally takes place independently of that disease. It may occur in any portion of the vessel, but that which is included within the pericardium is most liable to such an accident, for reasons already assigned. In some cases, the rent is confined at first to the internal and middle coats, the cellular coat resisting for a time, and finally yielding, in consequence of some violent effort, or the gradual influence of disease; but occasionally the whole of them give way simultaneously, and the individual falls down dead, in consequence of the sudden extravasation of blood. The artery may also be opened by ulceration; by the influence of calcareous scales upon the adjacent portion of its tunics; by atheromatous degeneration, &c. When it is the consequence of a rent, the solution of continuity may be either longitudinal, oblique, or circular; and sometimes it presents a different direction in the internal and middle, and the external tunics.

Cases of this accident, though not very common, are not unfrequently observed. We have seen two examples in bodies brought in for dissection. In one of them, the rent occupied the abdominal aorta, and took place in consequence of calcareous degeneration of the coats of the aorta. The other was seated in that portion of the vessel which is included in the pericardium, and seemed to have resulted from a preternatural friability of the tunics. Ploucquet refers to an instance, in which rupture took place in consequence of a blow on the hypochondrium. (*Ephemerid. de Nat. Curios.* Dec. III. Ann. ii. Obs. 70.) A case is reported by Morgagni, of an individual who had been long affected with syphilis. The aorta ruptured within the pericardium while he was ascending a flight of stairs (*Epist.* LIII. 7.); and in the same Epist. No. 35., another example is recorded, in which a rupture of the aorta was occasioned by a blow on the back. A case is published by James, in which rupture took place in a healthy seaman, while in the act of jumping out of his hammock (*Lond. Med. and Phys. Journ.* XVIII.), and Dr. Elliotson mentions two instances, both in females, in which the aorta was ruptured within the pericardium. In one of them, the accident took place in the act of stooping. (*Lond. Med. and Surg. Journ.* II. 364. 1833.) He also alludes to another, delineated in Mr. Allcock's plates. In a case reported by Arnott, the rupture was occasioned by a fall from a scaffold (*Lond. Med. and Phys. Journ.* LVIII. 19.), and in the same work, p. 15., another example is detailed by Rose, in which the coats of the artery were extensively diseased. In an instance recorded by Hume, in the *Glasgow Medical Journal*, IV. 148., the rupture, as in James's case, was occasioned by the exertion of getting out of bed. (Copland. *Loc. Cit.* 78.) The most interesting examples of this lesion are, however, two which have been reported, the first by Laurencin (*Archives Gén.* VI. 301.), the second by Léger. (*Dict. de Méd.* III. 424.) In these cases, the rupture was occasioned by a fragment of bone impacted in the œsophagus.

For the description of the nervous affections of the aorta, we must refer to *Abdomen, pulsations of.*

Bibliography.—Besides the above references, see—

P. H. Berard. Art. *Rupture de l'Aorte,* in Dict. de Méd. 2d edit. III. 424.

Copland. Dict. of Pract. Med. Pt. I. p. 78. 1833

E. Geddings.

APATHY. (From α priv. παθος, affection.) απαθεια, Gr.; *Apatheia*, Lat.; *Apathie*, Fr. A deadness of the moral feelings, or immobility from impressions which violently excite most persons. It may depend on the organization, and is often the appanage of the lymphatic temperament. Not unfrequently it results from long continued violent excitement, and various external, physical, and moral causes. Its occurrence in diseases is of unfavourable import, indicating a serious lesion of the nervous system. I. H.

APEPSIA. (From α priv. and πεψις, coction.) Indigestion (q. v.). I. H.

APERIENT. (From *aperire*, to open.) *Aperiens*, *Aperitivus*, Lat.; *Aperitif*, Fr. During the prevalence of the mechanical doctrines, diseases were ascribed to an obstruction or contraction of the vessels, and this term was then employed to designate a class of medicines supposed to have the power of opening the canals or passages of the body. These remedies were divided into deobstruents, resolvents, attenuants, and incisives, according as they were believed to act by dilating the vessels or by diluting their contents. As thus defined, and this definition is sustained by its etymology, such a class is purely imaginary. At present the term is employed only as synonymous with *Laxatives* (q. v.). I. H.

APHELXIA. (From αφελχω, I abstract.) Revery. This is defined by Dr. Good, to be an "inactivity of the attention to the impressions of surrounding objects during wakefulness." He makes three species of it: 1. *A. socors*, absence of mind; 2. *A. intenta*, abstraction of mind; 3. *A. otiosa*, brown study. The following is Dr. Good's graphic description of these species, as given in his Study of Medicine.

Sp. 1. *A socors*, absence of mind; truant attention; wandering fancy; vacant or vacillating countenance.

This is an absence or vacuity of mind, too common at schools and at church; over tasks and sermons; and there are few readers, who have not frequently been sensible of it in some degree or other.

In reading books in which we are totally uninterested, composed in a tedious and repulsive style, we are almost continually immersed in this species of revery. The will does not exert its power; the attention is suffered to wander to something of stronger attraction; or the imagination is left to the play of its own nugatory ideas; and, though we continue to read, we have not the smallest knowledge of the argument before us: and if the subject, to which the train of our thoughts is really directed, be of a striking ludicrous character, we may possibly burst into a laugh in the middle of a discourse of great gravity and seriousness, to the astonishment of those around us.

This is a common case, and may lead to great embarrassment. We have nevertheless thus far supposed, that the will does not exert its power, and sufficiently rein in the attention to the subject addressed to it. It not unfrequently happens, however, that the will, for want of a proper habit, has lost its power, either wholly, or in a very great degree, and cannot, with its utmost energy, exercise a due control over the attention; and it also happens in other cases, from a peculiarity of temperament, or morbid state of body, that the faculty of the attention itself is so feeble, that it is incapable of being steadily directed for more than a few minutes to any object of importance whatever, with all the effort of the will to give it such direction.

The mind, under either of these conditions, is in a deplorable state for all the higher purposes of reflection and knowledge, for which by its nature it is intended; since it is upon the faculty of attention that every other faculty is dependent for its vigour and expansion: without it, the perception exercises itself in vain; the memory can lay up no store of ideas; the judgment draw forth no comparisons; the imagination must become blighted and barren; and where there is no attention whatever, the case must necessarily verge upon fatuity.

In early life, the attention, like every other faculty of the mind, is weak and wandering, is often caught with difficulty, and rarely fixed upon any thing. Like every other faculty, however, it is capable of being strengthened and concentrated; and may be made to dwell upon almost any object proposed. But this is a work of time, and forms one of the most important parts of education: and, in the course of this discipline, it should not be forgotten, that the faculty of attention, when it first shows itself, is more readily arrested by some subjects, than by others, and that it is hence of great moment to ascertain those subjects, and to select them in the first instance. The habit is what is chiefly wanted, and the quicker this is acquired, the more time we gain for transferring the same habit to other and perhaps more valuable purposes afterwards.

This is a point seldom sufficiently considered in the course of education; and, for want of such consideration, far more than half the time of many boys becomes

an entire blank, and is lost, and not a few suffered to remain blockheads in the particular department to which their hours of study are directed, who might discover a considerable capacity and genius, if the department were changed for one more adapted to their own taste, or, in other words, more attractive to their attention.

There is a very singular instance of habitual absence of mind related by Sir A. Crichton, in a young patient under the care of Dr. Pitcairn and himself, which, though some other circumstances appear to have combined with it, is ascribed considerably to the error of education we are now speaking of, that of not duly studying the peculiar bent of a mind in many respects singularly constituted, and drawing forth and strengthening the faculty of attention, which was in an especial degree weak and truant, by an employment of such objects and pursuits as were most alluring. This patient was a young gentleman of large fortune, who, till the age of twenty-one, and he does not seem to have been much more at the time of describing his case, had enjoyed a tolerable share of health, though of a delicate frame. In his disposition, he was gentle and calm, but somewhat unsociable. His absence of mind was extreme, and he would sometimes willingly sit for a whole day without moving. Yet he had nothing of melancholy belonging to him; and it was easy to discover by his countenance, that a multiplicity of thoughts were constantly succeeding each other in his imagination, many of which were gay and cheerful; for he would heartily laugh at times, not with an unmeaning countenance, but evidently from mental merriment. He was occasionally so strangely inattentive, that, when pushed by some want which he wished to express, if he had begun a sentence, he would suddenly stop short after getting half-way through it, as though he had forgotten what else he had to say. Yet when his attention was roused, and he was induced to speak, he always expressed himself in good language and with much propriety; and if a question were proposed to him, which required the exercise of judgment, and he could be made to attend to it, he judged correctly. It was with difficulty he could be made to take any exercise; but was at length prevailed upon to drive his curricle, in which Sir Alexander at times accompanied him. He at first could not be prevailed upon to go beyond half a mile; but in succeeding attempts he consented to go farther. He drove steadily, and when about to pass a carriage, took pains to avoid it: but when at last he became familiarized with this exercise, he would often relapse into thought, and allow the reins to hang loose in his hands. His ideas seemed to be for ever varying. When any thing came across his mind which excited anger, the horses suffered for it; but the spirit they exhibited at such an unusual and unkind treatment made him soon desist, and re-excited his attention to his own safety. As soon as they were quieted, he would relapse into thought: if his ideas were melancholy, the horses were allowed to walk slow; if they were gay and cheerful, they were generally encouraged to go fast.—*Of Mental Derangement*, vol. I. p. 281.

Perhaps, in this case, something might have been owing, as supposed by Sir A. Crichton, to an error in the mode of education; but the chief defect seems to have been in the attentive faculty itself, and its labouring under a natural imbecility, which no mode of education could entirely have removed. We have had frequent occasions to observe, that the powers of the mind vary in different individuals as much as those of the body: and we have already offered examples of weak or diseased judgment, weak or diseased perception, and weak or vehement imagination. In the case before us, the mental disease seems to have been chiefly confined to the faculty of attention; and we shall presently have to notice a similar imbecility of the memory, and even of all the mental faculties conjointly.

Sp. 2. *Aphelxia Intenta.*—Abstraction of mind. The attention wound up and riveted to a particular subject; with sympathetic emotion of the muscles and features connected with its general drift.

In this species, the faculty of attention, instead of being feeble, or contumacious to the will, is peculiarly strong, and vehemently excited, and acts in perfect cooperation with the will itself. And, in many instances, the sensorial energy maintained is so great, and demands so large a supply of sensorial power as apparently to exhaust the entire stock, except indeed the reserve, which is in almost all cases instinctively kept back for the use of the vital or involuntary organs. And hence, all the external senses remain in a state of torpor, as though drawn upon for their respective contributions of sensorial power in support of the predominant meditation; so that the eyes do not see, nor the ears hear, nor the flesh feel; and the muser may be spoken to, or conversation

may take place around him, or he may even be struck upon the shoulders, without any knowledge of what is occurring.

Abstraction of mind may be produced by various causes, but the following are the chief, and form two distinct varieties:

α Aphelxia à pathemate: from some overwhelming passion.

β Aphelxia à studio: from intense study.

Of the first variety we have already offered abundant examples in the two preceding genera: and especially in the cases of ungovernable joy or rapture, grief and despondency: under the influence of which the affected person is often as much lost to the world around him, as if he were in a profound sleep and dreaming; and only hears, sees, and feels the vivid train of ideas that possess themselves of his mind, and rule it as a captured citadel. To these alone the attention is directed: here it exhausts all its power, and the will concurs in the exhaustion; insomuch that the patient is said in some cases to have stared at the meridian sun without pain.—(Blumenb. *Bibl.* I. p. 736.) And in others to have been undisturbed by the discharge of a cannon.—(Darwin, *Zoonomia*, III. I. ii. 2.)

We meet with like proofs of this variety of revery in many cases of intense study, and especially upon abstract subjects, as those of pure mathematics, in which all the reasoning and more serious faculties of the mind, as the perception, the memory, and the judgment, as well as the attention, are jointly called into action, and kept equally upon the stretch. Of the power of this variety of revery in rendering an individual torpid and almost dead to all around him, we have a decided instance in Archimedes at the time of his arrest. When the Roman army had at length taken Syracuse by stratagem, which the tactics of this consummate engineer prevented them from taking by force, he was shut up in his closet, and so intent on a geometrical demonstration, that he was equally insensible to the shouts of the victors, and the outcries of the vanquished. He was calmly drawing the lines of a diagram when a soldier abruptly entered his room, and clapt a sword to his throat. "Hold, friend," said Archimedes, "one moment, and my demonstration will be finished." The soldier, surprised at his unconcern at a time of such extreme peril, resolved to carry him before Marcellus; but as the philosopher put under his arm a small box full of spheres, dials, and other instruments, the soldier, conceiving the box to be filled with gold, could not resist the temptation, and killed him on the spot.

Sp. 3. *Aphelxia Otiosa.*—Brown-study. Leisurely listlessness; voluntary surrender of the attention and the judgment to the sportive vagaries of the imagination: quiescent muscles; idle gravity of countenance.

The attention is equally summoned into action and dismissed at the command of the will. It is summoned in the last species: it is dismissed, when a man voluntarily surrenders himself to ease and listlessness of mind; during which period, moreover, in consequence of this indulgence in general indolence, the external senses themselves unite in the mental quiescence, and a smaller portion of nervous energy is probably generated for the very reason that a smaller portion is demanded; and hence the active senses without are as vacant and unstrung as the active senses within, and as blunted to their respective stimuli. The first playful ideas that float over the fancy in this case take the lead, and the mind relaxes itself with their easy and sportive flow. It is the *studium inane* of Darwin, (*Zoonom.* III. I. ii. 2; and again, IV. II. iv. 2.) who seems, however, to have in some degree misapplied the name, or to have confounded the aberration with that of ecphronia or alusia. Cowper has admirably described it. (*Task*, book IV.)

In the indolent mind, such indulgence is a disease, and, if not studiously watched and opposed, will easily become a habit. In the studious and active mind, it is a wholesome relaxation: the sensory, in the correct language of the poet, "sleeps and is refreshed," grows fertile beneath the salutary fallow, and prepares itself for new harvests.

This is more particularly the case where, in conjunction with an attention "screwed up to the sticking place," and long continued there, a spirit of ardent emulation is at the same time stirring, and distracted between the hope and fear of gaining or losing a distinguished honour or reward. I have seen this repeatedly in young men who have been striving night and day, and week after week, for the first prizes of our English universities; some of whom have indeed succeeded, but with a hectic exhaustion that has been recovered from with great difficulty; while others, in the full prospect of success, have been compelled to relinquish the pursuit, and to degrade.

Yet even without this conflict of feeling, where the attention alone has been too long directed to one or to a variety of recondite subjects, without relaxation, the mind suffers considerably, and its powers

become shaken and confused; of which we have an interesting example in the case of Mr. Spalding, a scholar of considerable eminence in Germany, as drawn by himself, and communicated to the editors of the Psychological Magazine. (Crichton's *Inquiry into Mental Derangement*, I. 237.) His attention, he tells us, had been long kept upon the stretch, and had been still more distracted by being continually shifted from one subject to another, when, being called upon to write a receipt for money paid him on account of the poor, as soon as he had written the two first words, he found himself incapable of proceeding farther. He strove all he could, and strained his attention to the utmost, but to no purpose: he knew the characters he continued to make were not those he wished to write, but could not discover where the fault lay. He then desisted, and partly by broken words and syllables, and partly by gestures, made the person who waited for the receipt understand that he should leave him. For about half an hour, a tumultuary disorder reigned in his senses, so that he was incapable of remarking any thing very particular, except that one series of ideas of a trifling nature, and confusedly intermixed, forced themselves involuntarily on his mind. At the same time his external senses continued perfect, and he saw and knew every thing around him. His speech, however, failed in the same manner as his power of writing, and he perceived that he spoke other words than those he intended. In less than an hour he recovered himself from this confusion, and felt nothing but a slight head-ache. On examining the receipt on which the aberration first betrayed itself, he found that, instead of the words "fifty dollars, being one half year's rate," he had written "fifty dollars, through the salvation of Bra—;" the last word being left unfinished, and without his having the least recollection of what it was intended to be. I. H.

APHONIA. (From α priv., and φωνη, the voice.) More or less complete loss of voice. Aphonia ought not to be confounded with dumbness (*mutitas*), as has often been done. The former consists in an inability to produce, the latter to articulate sounds. In the former, generally, the voice is not completely extinct, but the patient is able to speak in a low voice or whisper; whilst in the latter, there exists the power of uttering loud sounds, without, however, the faculty of pronouncing syllables or words.

The production of the voice is the office of a complex apparatus, and its extinction results from most of the lesions of this apparatus. Aphonia is consequently not a disease, but a symptom—the expression of a pathological condition of some of the organs of phonation.

The causes of aphonia are very numerous and diversified; the organs which form the voice being subject to many primary diseases, as well as liable to be sympathetically affected, by the derangements of several other organs with which they hold close sympathetic relations. It would not be possible, however, to discuss with any practical advantage, the causes of this symptom, its indications, and the means of relieving it, separately from the anatomical consideration of the organs of voice, and of the various pathological conditions which affect their functions; the whole will, therefore, be exposed together in the article *Voice*, to which the reader is referred. I. H.

APHRODISIACS. (From αφροδιτη, Venus.) Remedies which have the power of increasing the venereal faculty, or of reviving it when extinct. The articles formerly supposed to be endowed with this virtue, are the tonics, aromatics, odoriferous gums, balsams, resins, essential and volatile oils, musk, phosphorus, and cantharides; all of which, with the exception perhaps of the last, are general stimulants, and have no direct and specific stimulant action on the genital organs. The cantharides, when administered in large doses, are well known to produce a violent irritation of the urinary organs, followed by priapism. But this is a disease, and not the normal condition or exercise of a function; and it is not very probable that coition, under the impulse of this irritation, would be productive of enjoyment, or likely to increase population. There appears, then, to be no real aphrodisiac; and modern systematic writers have very justly discarded such a class. The means of invigorating the powers of the sensual organs are of a general character, and will be exposed in the article on *Impotence*. I. H.

APHTHÆ. (From απτω, I inflame.) *Aphthæ*, Lat.; *Aphthe, Apte, Muguet, Catarrhe buccal*, Fr.; *Thrush, Sprue, Infant's sore mouth*, Eng. An inflammation of the mucous membrane, with elevation of the epithelium, in round, oval or irregular, whitish or ash-coloured vesicles; the contained fluid of which is said to be separated into two parts; one albuminous, forming the rudiment of the new epidermis,—the other serous, which escapes while the old epidermis is cast in the form of scurf or scab. (Craigie. *Elements of Gen. and Path.*

Anat. p. 672.) It affects, most commonly, the inner surface of the lips and cheeks, the gums, roof of the mouth, tongue and its frenum, and the posterior fauces; less frequently, the œsophagus, trachea, and verge of the anus. It seldom or never invades the schneiderian membrane; at least we have never witnessed an instance of its occurrence there; and both Callisen and Bateman admit the exemption of this part from the disease. It still remains an unsettled point, among pathologists, whether or not aphthæ ever form in the stomach and intestinal tube; some declaring they do, while others deny it. We cannot venture, with safety, to appeal to our own experience, as regards this question, for our testimony would amount only to this negative,—that we have never seen them in the parts in question, nor have many other practitioners of high authority. But, on the other hand, several anatomists of unquestionable character have declared that they have met with aphthæ in the mucous membrane of the stomach and bowels. It may however be asserted, that they are most characteristically developed in the mucous membrane in which the epithelium is most apparent.

Authors, especially those of olden times, have been very liberal in the application of the term aphthæ, and have comprised under it many affections of the mouth which bear not the slightest analogy with this complaint.

In the present article we shall not inquire into the propriety of the distinctions which have been made between the various diseases of the mouth—this will more properly be discussed elsewhere (see *Stomatitis*); but shall confine ourselves to the consideration of the affection to which the term aphthæ really belongs.

This complaint has attracted much attention from modern pathologists, who, though they have agreed as to the tissue it invades, differ respecting the particular portion of this tissue which is its seat. It is admitted that aphthous inflammation is located in the mucous membrane; but this is a complex tissue, and it is not decided, to this moment, which portion of it constitutes the particular seat of aphthæ. Neither Gardien, Duges, Guersent, nor any other writer whom we have consulted, has attempted to determine a point which Bichat himself left undecided; for he inquires: "Les aphthes sont-ils aux papilles? Siegent ils dans les glandes? Sont ils une inflammation isolée de ces glandes, tandis que les catarrhes sont characterisés par une inflammation generale d'une etendue assez considerable du systeme muqueux?" Billard, however, undertakes the explanation, and declares the seat of aphthæ to be in the muciperous glands of the mucous membrane. He adduces many reasons for his belief, and with apparent truth; and names one circumstance which gives a strong probability to the propriety of his location; which, if true, (for we have not had an opportunity to test its accuracy), would seem to settle the question. He says, "the muciperous glands of the mucous membrane of the mouth are invisible in their natural and healthy condition, being hidden in the substance of the membrane, and by their number make up for the smallness of their size. When they become inflamed, they tumefy, show themselves in the form of small white spots, sometimes a little coloured in their centres, somewhat elevated, and frequently surrounded by a slight inflammatory circle. *Occasionally these small elevations can be felt by the finger before they become visible to the eye.*" If this be found true by future observations, it will place the seat of the aphthous inflammation in the muciperous glands of the mucous membrane of the mouth, &c.

Though emphatically called the baby's sore mouth, this affection is not confined exclusively to very young children, but often occurs in adults labouring under wasting discharges, or lymphatic engorgements. It may be said, however, with much certainty, we think, that aphthæ, as an essential disease, is confined to infancy and childhood; but it may also exist in them as a symptomatic affection; for children, as well as adults, are liable to wasting and chronic diseases. Bateman seems to think that aphthæ may primarily occupy the stomach, and then travel up the œsophagus to the pharynx; a circumstance, in our estimation, of very doubtful character, and not very susceptible of proof; for the symptoms which he says accompany this location of the disease, and mark its progress, from its original seat to the mouth, (as anxiety and oppression about the precordia), are too common, as well as too vague, to establish either the origin, or the seat of this affection.

Causes. The remote and exciting causes of aphthæ are numerous, highly influential, widely spread, and constantly operating. Among the most prominent is the foul air produced by many bodies being crowded together, as in hospitals and asylums for children, where both the sick and well inhabit the same apartments, and breathe the same atmosphere. Dark and cavernous

dwellings, an ill-prepared and innutritious state of the mother's or nurse's milk, and a feeble constitution, especially from imperfect development or premature delivery, are productive of aphthæ, generally of the worst character. To these causes may be added, food of an unsuitable quality, as well as quantity; ascescent milk, or other substances about to ferment from long standing, or from too much sweetening; a want of cleanliness; too great a confinement to the bed, or cradle, &c. But there is no one cause of idiopathic aphthæ that is so frequent and so certain as the want of the mother's milk, soon after birth. It too often happens, from a variety of causes, that the secretion of milk does not take place early enough, or continue with sufficient certainty, for the necessities of the child. The mother may be ill before labour, or immediately after; the nipples may be badly formed or sore; abscesses may form, and prove destructive of the organization of the mammæ, &c. From either of these causes the child is deprived of its natural nourishment; in consequence of which, instead of being supplied immediately with a fresh breast of milk, it is forced to swallow an unnatural and ill-prepared substitute; and which thus becomes one of the most powerful causes of aphthæ.

The exciting causes are nearly the same as the predisposing. They are whatever stimulates, either mechanically or chemically, the tender mucous membrane, as food, acid from fermentation; or unsuitable to the age of the child, as animal substances, to very young subjects, food given too hot, or too tenacious for the power of the stomach; mechanical injury, from rude attempts to clean the mouth; or this performed with an improper material, as flannel or coarse muslin, under the pretence of keeping the mouth clean. This kind of discipline is a more fruitful source of the disease than is commonly supposed, and therefore it should be carefully avoided. The removal of the recrements of food from the mouth is a very proper operation; but it should be managed by a tender and careful hand, with a piece of very fine linen, and with simple water only. We are of opinion, that many children would escape the painful, and sometimes dangerous affection in question, were they not subjected to this rude manœuvre.

Symptoms. This affection has its premonitory symptoms, but not always in a very obvious degree. The child is generally more thirsty than usual, manifested by the greatness with which it takes the breast, and this is observable even at a very early age; the lips are sometimes, for several days, more than naturally red; so also the tongue and gums. This condition of redness is natural, however, to all very young children, and must not, therefore, be looked upon always as a morbid condition of those parts. The child also becomes fretful, and often even cries as if it were in pain; and this before the appearance of the eruption. It is likewise disposed to sleep more than its natural wont, as well as more profoundly. Fever sometimes precedes, but not necessarily; and this state of the circulatory system is detected more by the thirst of the child, and its breathing, than by the pulse; for the pulse, in very young children, is not easily detected, and if found, not easily counted. Indeed, according to Billard, there is more uncertainty in the number of pulsations of the arteries in a given time, than is usually supposed.

After a continuance, for a longer or shorter time, of the premonitory symptoms, if they exist, transparent vesicles, of a light grayish colour, may be observed to show themselves upon one or several places, within the mouth and lips. These vesicles are surrounded at their bases by small inflamed circles, which are a little thickened, or elevated, almost as in scarlatina or measles, above the surface of the mucous membrane. These harden as they develop themselves, and thus give rise to the vesicular form of the eruption. This vesicular character increases until the second or third day: the vesicles then open spontaneously, and give issue to a whitish or pearl-coloured fluid, leaving behind an ulcerous appearance. This change in the aspect of the vesicles is attended by more or less pain, as is manifested by the unwillingness of the child to take the breast, and its apparently suffering inconvenience in its attempts to extract the milk. It often lets the nipple slip from its mouth, which it seizes again with apprehension.

The period of this ulcerous condition is of uncertain duration; but it generally occupies from three or four days, to as many weeks, according as the recuperative powers of the system may be more or less favourable; to the force and continuance of the remote causes, and as the mode of treatment may be more or less appropriate. The ulcerations, during this period, if the parts are not healthily disposed, rather increase in size for some time; but after a while the bases of these little pits become slightly red, and show a disposition to cicatrize. Their size gra-

dually diminishes, and they sink to the level of the membrane beneath.

The progress of healing, after it commences, is pretty rapid in general, unless some cause of retardment should supervene, to renew the aphthous inflammation; as an improper plan of treatment, or a renewal or multiplication of the remote causes, which sometimes happens: hence the succession of crops of the aphthous efflorescence. These exfoliations are renewed sometimes, without our being able to assign the cause. But, under the best circumstances, it requires only two or three days for the stratum of hardened lymph to be thrown off, by a kind of exfoliation. After this is successfully performed, the epithelium beneath betrays no signs of the previous ulceration, except that it remains for some time more red than natural. This form of aphthæ is called, by several of the French writers, "discrete aphthæ," and is the mildest, and, under favourable circumstances to the patient, the most common. The disease, in this form, will run its course in from one to three or four days, and rarely disturbs the functions of the system; and the child is soon restored to its usual health.

In contradistinction to these mild aphthæ, a severer condition is sometimes formed, especially in very young and feeble children; and particularly when not in possession of a healthy breast of milk, or other suitable nourishment. Children worn down by previous illness of any sort, are liable to severe and sometimes dangerous aphthæ; which is, however, nothing more than an exalted pathological condition of the mucous follicles of the part or parts involved in the inflammation.

To make different species of aphthæ, when these distinctions are derived merely from the portion of the mouth the efflorescence may chance to occupy, or from the forms the patches of aphthæ may assume, is surely unnecessary, if not embarrassing and hurtful. For in all the modifications of this disease, the symptoms, the tissue, the progress, the exfoliations, the appearance of the tissue beneath, the process of cicatrization or deterioration, are the same, differing only in degree. This rage for making species has been carried to such extent by some, as to cause a difference in name for the disease, as it may be situated upon the tip or back part of the tongue, and even according to the thickness of the respective mucous coatings; nay, the size of the pustules, on this organ, has been claimed as a ground of distinction. But can any therapeutical advantage be derived from this attempt to establish varieties of aphthæ from these circumstances? We might as well create new names for the different sizes of phlegmon, or for the different degrees of intensity in the paroxysms of an intermittent, or for the different degrees of inflammation in ophthalmia. Did the severity or mildness of aphthæ depend upon their occupying distinct tissues, it might then be important to ascertain to which tissue each form belonged, and they then would be entitled to specific names. But, as the mild and malignant forms of aphthæ occupy the same organization, there can be no propriety in designating them but from the respective degrees of inflammation. That their phenomena will be somewhat different, we will freely admit; but even these will depend more upon the intensity than upon any specific difference in the inflammation or variety of tissue they may occupy.

The most remarkable differences, in the several stages of this affection, are the number of the mucous follicles that may be involved by this peculiar modification of inflammation. In one form only a very few may be implicated, as in the mildest form; in a severer form, very many may be involved. Yet in these instances the vesicles undergo the self-same changes during their progress, though this difference in appearance may exist. In the first instance, the vesicles are too few to coalesce and form a continuous crust; whereas, in the other, their number being great, they will pour out their contents much more abundantly, and form an extensive crust, which being cast off, another and another may form, as the remote cause continues to act, or as the inflammation may continue to exist, or as the treatment may have been appropriate or otherwise.

In a more aggravated form, as in the confluent, or, as some have termed it, the "stationary," the symptoms are more serious and tormenting, and the child is evidently a much greater sufferer. The throat becomes affected, and a great difficulty is experienced in swallowing, in consequence of the posterior fauces and pharynx being much loaded by the eruption. The child, in this stage of the disease, is importunate for drink, but deliberates about receiving it when it is presented, from the suffering it experiences on every attempt to swallow; and the patient will oftentimes reject it, rather than encounter the pain. We once saw a case of this kind, where the child would permit

nothing to be put into its mouth, and absolutely died from inanition. Upon examining it after death, the œsophagus, as far as the cardia, was literally blocked up with aphthous incrustations. But the efflorescence stopped at the cardia, nor was there a trace of the disease in either the stomach or bowels, though the verge of the anus was covered with this eruption; which, most probably, was caused or called into action by the frequent discharge of an acrid and greenish-looking fluid.

This stage or form of aphthæ is almost always sure to be attended by frequent vomitings of porracious matter; great anxiety about the precordia; rapid, and if it continue long enough, extreme emaciation, from profuse and harassing diarrhœa; and under certain circumstances, as in crowded hospitals, &c., a consuming fever, of a low grade, is almost sure to ensue, and hasten on the disease to a fatal issue.

Non-Contagiousness. This disease is looked upon by some as contagious, but of this we have the strongest doubts; though it is pretty generally admitted to be occasionally epidemic. The proof offered of its being a contagious disease is every way insufficient; namely, its excoriating the nipples of the mother. First, because we have seen the nipples remain uninjured, though the child may have had the disease in an exalted form; secondly, because sore or excoriated nipples are very common, where there is no aphthous mouth to produce them; and thirdly, we have known an aphthous child to be kissed frequently by other children, without the disease communicating itself.

Prognosis. Our prognosis must be governed by several circumstances, each of which will have a strong bearing on this point. As a general rule, the younger the subject, the greater the risk, even if the aphthæ be of a mild form; as the recuperative powers of the system are weak in such cases. The risk is increased, if, added to this early age, the system be weak from imperfect development, or rendered so by previous suffering; and especially if, added to this, the patient be subjected to the action of bad air, bad milk, improper diet, constant want of cleanliness, &c.

If the aphthous efflorescence spreads rapidly, and becomes of a dark colour, without exfoliating, and invades the whole of the fauces, tongue, and œsophagus, to such an extent as to render it difficult for the child to take a proper share of the most suitable nourishment; or should frequent dejections take place of a thin offensive greenish water, or should the stomach revolt, and puking ensue; and if fever be added to these, the case may be looked upon as nearly hopeless under the circumstances of age and constitution just named; but an older child, with a better constitution, and proper nourishment at command, may struggle through the disease, unless it be symptomatic; then the inferences must be drawn rather from the state of the symptomatic disease, than from the condition of the aphthæ itself; remembering, in forming an opinion of the disease, that its danger is always augmented by the presence of aphthæ. This may be said of aphthæ at any period of life, or under any circumstances of free ventilation, proper nourishment, and treatment; therefore, the sympathetic, or systematic, is always (*cæteris paribus*) more dangerous than the idiopathic form.

Should aphthæ be attended with fever as one of its symptoms, it will denote increased danger, as it will show that the system sympathizes with the local affection; for we have said that fever, especially an exalted degree of it, is not an essential character of aphthæ.

On the other hand, when aphthæ is idiopathic; the eruption not erratic; the constitution good; the air pure; the nursing and food appropriate, the disease is of easy management, and under such circumstances rarely becomes alarming, and many times scarcely inconvenient. But even under these favourable circumstances, the disease may by mismanagement become alarming, though the efflorescence may be sufficiently limited; the danger not being always commensurate with its extent. For we have seen very alarming symptoms succeed to this apparently mild and safe form, without being able to say by what agency the change has been produced. When this happens, the child becomes fretful and drowsy; the bowels yield, and diarrhœa occurs; the exfoliations from the mouth take place in detached spots, leaving the epithelium very tender, dark coloured, and disposed to bleed on very slight injury. Fever is augmented, thirst increased, swallowing becomes difficult, the secretions of the mouth are arrested, and the tender epithelium, especially on the lips, cracks, and remains so for some time. This condition prevents the child from closing its mouth sufficiently tight to extract the milk from the breast, and it thus suffers from want of nourishment. This painful and threatening condition may

however, be frequently subdued by proper management and appropriate treatment.

Treatment. In treating this disease, except perhaps in its very mildest forms, much care is required, both as regards local and general management; otherwise a mild grade may be changed into one of danger and severity. The first care should be, to abstract the remote cause or causes, as far as this is practicable. An impure should be exchanged for a pure air, and an innutritious or impure milk should give place to milk of opposite qualities; cleanliness must be substituted for filth; food, of quality and in quantity adapted to the age and constitution of the child, and force of the disease, must be furnished.

The cruel and preposterous practice of scrubbing the mouth, under the pretext of its being an essential step in the cure, must be prohibited in such a manner as to prevent its repetition. This practice is one of the many vulgar errors connected with the management of children, which every endeavour must be made to correct. It has taken its rise from the notion that the mouths of all young children are filthy, and that this condition is the cause of aphthæ; and as the coarseness of the material, and the force of the hand that employs it, will necessarily remove the white aphthous crust, it is vulgarly believed that they remove the disease. Under this delusion, the plan is persevered in, though every repetition shows the parts to be covered by a new crop of aphthæ, and this even to a greater degree. This new product excites no doubts of the propriety of the course, but rather, on the contrary, induces a perseverance in it with increased energy and additional force of hand. Some stimulating substance, as honey, molasses, or soap, is even added to the piece of rough flannel; and this plan is pursued with such cruel industry, that blood is almost sure to follow the violence. In this manner, the simple forms of aphthæ are converted into those of much greater severity, as well as danger. For the maintenance of cleanliness, it is only necessary to have the mouth gently washed with cold water and a piece of fine rag, once a day, and this especially in the morning.

In the commencement of aphthæ, if preceded by erythema, the mouth should not be touched, even by cold water, as every increase of irritation, however small, augments the mischief: the only topical application we permit in this state of the disease, is the very frequent use of a pretty rich infusion of the slippery-elm bark (*Ulmus fulva*). This, in small quantities, is to be poured into the mouth, very frequently, which relieves the painful irritation almost immediately. This should be continued, until the inflammation subsides, which it generally does as soon as the aphthæ appear, or until they so much abate that there may be no apprehension from the use of a gentle stimulant. The best for this, in our estimation, is the borate of soda and loaf-sugar, in equal quantities, or with a lesser proportion of the borax if the inflammation persevere. These articles are to be very finely pulverized, and of this powder a small pinch is to be thrown dry, into the mouth, three times a day, and permitted to spread itself over the tongue and mouth by its solution in the saliva. We are aware that Dr. UNDERWOOD and some others have no confidence in any local application; and the French writers in general oppose the employment of the borax; but our own experience in this plan, justifies the use of this article, we think, most fully; it rarely indeed disappoints us. It is true, it may be used too strong, or too frequently for the immediate condition of the mouth; this should be carefully guarded against, by a careful examination of the state of the disease, and the quantity of the borax regulated by the less or greater intensity of the inflammation.

The crust, or white efflorescence, is removed very quickly by the application of the borax and sugar; but if the inflammation continue, a fresh secretion takes place. A few applications of this remedy, however, will very soon abate the inflammation; and after the crust is removed, the surface of the epithelium becomes less and less red, if everything goes on right. But if we find that instead of the reformation of the white crust, the epithelium is left very red and smooth, and the parts very sensible to the touch or to the motions of the tongue and jaws, the borax must be suspended and the slippery-elm tea substituted, until these appearances abate or are removed. We have found, under this state of things, the Armenian or red bole, mixed in equal proportions with sugar, very serviceable; or if the epithelium yield and break into chaps, or should the gums and the inside of the cheeks be disposed to ulcerate, the decoction of bark is the best and indeed a most certain remedy. Half an ounce of the powdered bark is to be simmered for fifteen minutes in half a pint of boiling water; it is then to be allowed to settle, and a little of it thrown into the mouth, five or six times a day.

During the use of these remedies, we never permit the mouth to be washed, as this is sure to interrupt the process of cicatrization; unless there should be a tendency to slough; in this case, the parts so circumstanced may be freely swabbed with the infusion, or even the dry powdered bark may be used.

The general treatment of aphthæ must depend upon the condition of the system at large. If fever attend, an antiphlogistic plan must be adopted; if debility be considerable, a nutritious or even sometimes a cordial treatment may be necessary. As diarrhœa is almost certain to precede or accompany aphthæ, remedies suitable to its nature and extent should be employed. When the stools are green or become so after standing, but not watery, magnesia in small and repeated doses will be found the best remedy; if yellow, and they are passed with pain or straining, a tea-spoonful, or more, according to the age and habits of the child, of castor oil, with a drop of laudanum, will be required. If the diarrhœa be importunate; the stools watery and green; or if mixed with the mucus of the bowels, the chalk mixture, with the free use of gum Arabic water, will be necessary. The oil of butter is highly useful in this state of the bowels. This is made by pouring boiling water upon a lump of butter; and when melted, a tea-spoonful is to be skimmed off, and given five or six times a day.

If the child suffer much from pain, the occasional use of laudanum, especially in form of enemata of rich flaxseed tea, will be proper. In this state of the mouth and bowels, very minute doses of calomel and chalk have been highly recommended. The anus is almost sure to be much irritated and inflamed, as well as the adjacent parts; constant attention should therefore be paid to them. They should be kept perfectly clean, by carefully washing them with warm rich flaxseed tea, and then covering the parts affected with a thin coat of fresh hogs' lard or simple cerate. A piece of what is called the oiled silk, such as is employed for hat covers, would be highly useful to prevent the contact of the diaper or clothes. The same diaper should never be used twice, without washing it.

In symptomatic aphthæ, the same local applications may be used; but nothing beyond temporary comfort must be expected, as the extent and severity will depend upon the disease which it accompanies; and for the treatment of this we must refer to the appropriate articles.

Wm. P. Dewees.

APIUM. (*Botany* and *Materia Medica.*) *Sex. Syst.* Pentandria Digynia.—*Nat. Ord.* Umbelliferæ.

Gen. Ch. Fruit ovate, striated. *Involucre* one-leafed. *Petals* equal. Willd.

1. *A. graveolens.—Celery.—Ache, Céleri*, Fr.; *Eppig, Sellerie*, Germ.—*Sp. Ch.* "Cauline leaves cuneiform." Willd.

Sp. Plant.—Celery is a biennial plant, with a spindle-shaped root, and an erect, furrowed, branching stem, rising from one to four feet in height. The leaves are smooth, shining, and of a dark green colour. Those which spring from the root are pinnate, with long, channeled, embracing footstalks, and roundish, three-lobed, incised-dentate leaflets. The cauline leaves are ternate, with leaflets which are wedge-shaped and three-parted, or entire and lanceolate. The flowers are small, whitish, and disposed in terminal and lateral umbels, which are either sessile or supported upon short footstalks, and are destitute of involucre, or have in the place of it a three-parted leaf. The fruit is similar to that of the species next described, but somewhat smaller.

Celery is a native of Europe, growing throughout that continent in ditches and wet places, particularly on the borders of salt streams, and near the sea-shore. It is extensively cultivated both in Europe and this country, for domestic use. All parts of the wild plant have a disagreeable odour, and a sharp bitter taste. These properties depend upon the presence of a peculiar volatile oil, and are lost or diminished by drying. The plant was employed as a medicine by the ancients, and is still retained in many of the Pharmacopœias of continental Europe. The root, herb, and seeds (*Radix, Herba*, et *Semen Apii*) are designated as officinal. The root appears to have been most used. It is diuretic; but is said also to be capable of producing deleterious effects upon the system, and is accused by some of having poisonous narcotic properties. Neither this nor any other part of the plant is at present much used as a medicine. The root was one of the *radices quinque aperientes majores*, and the fruit one of the *semina quator callida minora*, of older Pharmacy.

The effect of cultivation upon this plant is remarkable. It loses its disagreeable odour and taste, and its deleterious properties, and becomes an edible vegetable of an exceedingly pleasant flavour. In the leafstalks and roots a degree of sweetness is developed; and the presence of mannite has been demonstrated in these

parts by Vogel. The leaves are employed as a condiment in soups; and the leaf-stalks, blanched by covering them with earth during the growth of the plant, are white, tender, and juicy, and in great estimation as a salad. The root of the ordinary garden celery is not without diuretic properties, and, in the form of infusion, may be advantageously used as an adjuvant to more powerful remedies in dropsical and nephritic affections.

2. *A. Petroselinum.—Parsley.—Persil*, Fr.; *Petersilie*, Germ.—*Sp. Ch.* "Cauline leaflets linear, involucels minute." Willd. *Sp. Plant.*—This is a biennial plant, with an erect, smooth, striated, branching stem, two feet or more in height. The leaves are decompound, with smooth, light-green, deeply incised leaflets, the lobes of which are linear-lanceolate and acute. The radical and lower cauline leaves are on long channeled footstalks; those on the upper part of the stem are less compound, and on shorter footstalks; the uppermost are simply ternate. The flowers are small, yellow, and disposed in compound terminal umbels, with a one-leafed general involucre, and partial involucres composed of six or eight awl-shaped leaflets. The petals are five, equal, roundish, and pointed, with their summits inflected. The fruit is roundish-ovate, somewhat compressed, and ribbed; and consists of two portions usually called seeds, connected by their flat surfaces, and separating when perfectly ripe.

Parsley is a native of Sardinia, Sicily, and Greece, and is now everywhere cultivated in gardens, chiefly for the sake of its leaves, which are much used as a condiment in culinary preparations. Its flowers appear in June, July, and August. There are several varieties of the plant, differing in the shape of the leaflets, which are in one very narrow, in another broader, and in a third wavy. The whole plant has a peculiar aromatic odour, dependent on a volatile oil, which is separable by distillation. By our national Pharmacopœia the root only is recognized; but the herb and fruit possess similar properties, and are directed by numerous medical codes on the continent of Europe.

The *root* (Petroselinum, Ph. U. S.) is spindle-shaped, sometimes branching, about as thick as the finger, and a foot or more in length. Its upper portion is marked by close annular wrinkles, the lower is smooth. Externally it is yellowish white, internally, fleshy and white, with a central yellow portion. Its taste is sweetish, aromatic, and pungent. Besides volatile oil, it contains saccharine and mucilaginous principles. By drying, it shrinks, becomes wrinkled and of a light yellowish-gray colour, and loses much of its odour and taste, which are entirely destroyed by time.

The *seeds* (*Petroselini Semina*) are small, not more than a line in length, ovate, flat on one side, about as thick as they are broad, somewhat curved inwards, with five prominent longitudinal ribs which are yellowish, while the intervals are of a dark greenish colour. They possess strongly the aromatic odour and taste of the plant, are somewhat bitter, and retain their sensible properties for a long time after drying.

The *volatile oil* may be obtained most conveniently from the seeds, of which one pound is said to yield from two to two and a half drachms. It is of a pale yellow colour, has the odour and taste of the plant, and upon standing deposits a white solid substance, which crystallizes in needles.

Therapeutic properties and uses. Parsley was known to the ancients as a medicine, and is still occasionally employed, though no great reliance is placed upon its virtues, and it is probably more used in domestic than in regular practice. Its properties are those of a gentle carminative diuretic, usually agreeable to the palate, and acceptable to the stomach. The complaint in which it is most esteemed is dropsy, in the treatment of which it is sometimes advantageously associated with other diuretics. The root, which is the part usually preferred for this purpose, is said occasionally to act with considerable energy. Dr. Chapman speaks of it in highly favourable terms. In his treatise upon Therapeutics and Materia Medica (I. 276.), he states that he has known it to cure ascites, after tapping had been twice resorted to. It is also useful in suppression of urine, the painful urination of nephritis, and in strangury from blisters; and has enjoyed the credit of possessing lithontriptic properties. The best form of administration is that of a strong infusion, which should be used very freely. Decoction is injurious, at least if long continued, by driving off the volatile oil. Dr. Cullen states that he has often tried the decoction, and not found it to produce any diuretic effect. The infusion, if taken warm, and if the patient be at the same time warmly covered, sometimes determines to the skin, and has therefore been employed to promote the eruption in exanthematous diseases.

The seeds have been used as a carmina-

tive, and for the same purposes as the root, in dropsical, nephritic, and calculous affections; but are at present seldom prescribed. Their dose is from ten to twenty grains in powder, and a drachm in infusion. It is asserted that, sprinkled in the state of powder upon the hair, or applied in the shape of ointment made with fresh butter, they are an effectual and safe remedy in cases of vermin infesting the head. (Richter. *Arzneimittellehre.* II. 465.)

The volatile oil, and the solid deposit from the oil called Parsley camphor, are said to possess the properties of the seeds in a concentrated state, and to be susceptible of the same practical applications. They are not, however, used in the United States.

The fresh herb has been highly recommended as an external application to painful swellings of the mammæ and other glands, to the stings of insects, and even to scirrhous tumours. It should be boiled with milk to the consistence of a poultice, and laid on the affected part.

Some of the Pharmacopœias of the continent of Europe direct a distilled water to be prepared from the herb and seeds, which is used for the same purposes as the plant itself, but is a very feeble preparation, and is unknown in the practice of this country.

Parsley is an ingredient in numerous diuretic and aperient preparations, which have at different times been recommended and employed. The herb, used as food, was formerly thought to have the property of aggravating and even producing epileptic fits; but there is no good foundation for this opinion, which may possibly have originated in the fact, that the *Æthusa Cynapium* or Fool's-parsley, a poisonous weed growing in the gardens of Europe, and bearing a considerable resemblance to the true parsley, has sometimes been employed for it by mistake.

Geo. B. Wood.

APNEA or APNŒA, APNEUSTIA. (From α priv. and πνεω, I respire.) Synonymes of *Asphyxia* (q. v.). I. H.

APOCENOSIS. (From απο, out, and κενωσις, evacuation.) Cullen and Swediaur have applied this term to morbid fluxes. I. H.

APOCYNUM. (*Botany* and *Mat. Med.*) Dogs-bane.

Sex. Syst. Pentandria Digynia. *Nat. Ord.* Apocyneæ.

Gen. Ch. *Cal.* very small, five-cleft, persistent. *Corol.* campanulate, half five-cleft, lobes revolute, furnished at the base with five dentoid glands alternating with the stamina. *Anth.* connivent, sagittate, cohering to the stigma by the middle. *Style* obsolete. *Stigma* thick and acute. *Foll.* long and linear. *Seed* comose. Nuttall.

This genus, in common with all those composing the natural order to which it belongs, is possessed of active qualities. All are acrid, purgative, and in some instances very poisonous, arising from the presence of a white and viscid juice, or of a peculiar principle. There are about twenty species of this genus known to botanists, of which but three are natives of the United States,—these are the *A. androsæmifolium*, *A. cannabinum*, and *A. hypericifolium*, to which some authors add a fourth, the *A. pubescens*, considered by others as a variety of *A. cannabinum*. The two first of these are recognized as officinal in the United States Pharmacopœia.

1. *A. androsæmifolium.*—Dogs-bane. *Sp. Ch.* "Leaves ovate, smooth on both sides, cymes lateral and terminal, smooth; tube of the corolla longer than the calyx." Beck. This species is by no means uncommon, growing naturally from Canada to Georgia. It is usually found in woods, hills, dry or sandy soils; rarely met with in limestone districts. It is perennial, herbaceous, generally about four feet high. The stem is smooth and covered with a tough and fibrous bark. The leaves are opposite, petiolate, ovate, entire, smooth on both sides. The flowers are in cymose racemes, of a flesh colour. The peduncles are furnished with minute acute bracts. The fruit is in the form of a pair of slender, linear, acute, drooping follicles, containing numerous, oblong, imbricated seeds, attached to a central receptacle and furnished with a long, downy, pappus. It is very lactescent, affording on the slightest incision a profuse exudation of a milky fluid, which on drying assumes the appearance of caoutchouc.

The part used is the root, which is large, lactescent, and of a disagreeably bitter taste; the active portion is the bark, which forms about two-thirds of the root. From some experiments of Bigelow, it appears to consist of a bitter extractive principle, a colouring principle soluble in water but not in alcohol, caoutchouc and volatile oil. Its active properties are, however, soluble in both these menstrua. Dr. Zollickoffer obtained 178 grains of alcoholic and 28 grains of watery extract from 3240 grains of the bark.

This root possesses emetic and diapho-

retic properties. In doses of from thirty to forty grains it very promptly induces emesis, occasioning slight previous nausea; hence it is well calculated for those cases in which it is wished to evacuate the contents of the stomach merely, without producing that relaxation of the muscular system, which is incident to a long-continued nausea. As a diaphoretic it is much inferior to many other of the vegetable emetics, as it requires very large doses in combination with opium to produce the desired effect. Like ipecacuanha, when given in small doses it gently stimulates the digestive apparatus, and thus produces a corresponding impression upon the general system.

2. *A. cannabinum.* Indian Hemp. *Chanvre Indien*, Fr.; *Fliegen Fangemdcs*, Germ.—*Sp. Ch.* "Stem upright, herbaceous. Leaves oblong tomentose beneath; cymes lateral, longer than the leaves." Loudon. There exists considerable dif-

ference of opinion among botanists, whether the *A. pubescens*, Brown, is a species or a mere variety of the *A. cannabinum.* They certainly resemble each other very closely in almost every particular and as their medical properties are identical, we have adopted a specific character which whilst it will include both, will at the same time serve to distinguish them from the other species of the genus. The Indian Hemp is a perennial plant, usually about two to three feet in height, having a red or brown stem, and oblong ovate, somewhat pubescent leaves. The flowers, which are small and of a greenish-white or yellowish-green colour externally, and pink internally, are collected in paniculate cymes. This species is found in most parts of the United States, growing in waste lands and neglected situations. The root, which is the officinal part, is horizontal, extending to a great distance; it is of a reddish-brown colour when young, but of a dark chestnut when old; when wounded it affords a milky juice, analogous to that spoken of above. In the fresh state, it has a nauseous, somewhat acrid and permanently bitter taste, and a strong and unpleasant odour. When properly dried, it is very brittle and is readily pulverized, affording a powder resembling that of ipecacuanha. The ligneous portion of the root is of a yellowish white, having some odour and a marked bitter taste. The cortical part is brown externally, white within, of a very bitter, nauseous taste, somewhat resembling that of the *Sanguinaria Canadensis.* According to Drs. Knapp and Griscom, who analyzed this root, it contains tannin, gallic acid, gum, resin, wax, fecula, colouring matter, lignin, and a bitter principle for which they both propose the name of *Apocynin*, and on which the activity of the root depends.

The Indian hemp acts powerfully on the system, producing emetic, cathartic, diuretic, and sudorific effects. Its first operation, in a full dose, is to cause much nausea, diminishing the frequency of the pulse, and occasioning a drowsiness independent of the exhaustion usually consequent upon vomiting; this latter is copious, and is soon succeeded by large and feculent watery alvine evacuations. A general perspiration almost invariably follows its exhibition. Its diuretic properties are not so universally displayed, being very manifest in some cases, whilst in others they do not display themselves in the slightest degree. It also acts as a sternutatory, exciting much irritation of the Schneiderian membrane. The fresh juice has likewise been employed as a lotion in several cutaneous affections.

The disease in which it has been found

most useful is dropsy, in which, from the concurrent testimony of many eminent practitioners, its remedial powers are unequivocal, sometimes acting as a hydragogue, and at others causing the most profuse discharges of urine, and thus relieving the tissues from their morbid burden. It appears very analogous in its effects in this disease, to the *Madar* (*Asclepias gigantea*), so celebrated in India in the treatment of dropsical effusions, and like that plant would perhaps prove useful in obstinate cutaneous eruptions. Dr. Knapp gives the details of several cases of intermittent fever and pneumonic affections in which he derived much benefit from this remedy, employed as a diaphoretic.

When administered as an emetic, it should be given in powder, in doses of from fifteen to thirty grains. Where its hydragogue or diuretic effects are desired, the best form is the decoction, made by boiling an ounce of the root in a pint of water, of which the dose is about a wineglassful two or three times a day. The watery extract will also act upon the bowels, in doses of from three to five grains, but not as efficiently as the decoction.

Besides the value of this plant as a therapeutic agent, it is entitled to notice for utility in the arts. The bark furnishes a fibre resembling hemp, but of a whiter colour and much superior in strength and durability, and a decoction of the whole plant gives permanent brown and black dyes, according to the mordant used.

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R. E Griffith.

APONEUROSIS. (From απο, from, and νευρον, a nerve.) This epithet was bestowed by the ancients on the white fibrous membranes, which they regarded as nervous expansions. The general consideration of these membranes, will be entered into in the article on the fibrous tissues, and the individual aponeuroses or fascia will be described in connexion with the regions they occupy. I. H.

APONEUROTIC. Appertaining to the aponeuroses. I. H.

APOPHYSIS. (From απο, from, and φυω, I rise.) A process of a bone

Apophyses of *Ingrassias*, the lesser wings of the sphenoid bone. I. H.

APOPLEXY. (From the Greek αποπλησσω, or αποπλησσειν, to strike, or smite, or to knock down suddenly or violently.) αποπληξια, Gr.; *Apoplexia*, Lat.; *Apoplexie*, Fr.; *Schlagfluss*, Ger.; *Apoplessia*, Ital.; called also, by some of the older writers, *Sideratis*, or planet-struck; or εμβροντετοι, *attonitus*, or thunder-struck; and by the French, *coup de sang*, or rush of blood.

The term apoplexy, from its etymology, would be applicable to almost every disease which attacks suddenly and with great violence; it is most commonly, however, restricted to an affection of the brain, giving rise to a sudden deprivation, more or less complete, of the functions of sensation, voluntary motion, and of the intellect, while those of respiration and circulation still continue, though generally with diminished vigour. It is in this sense, the term will be employed in the present article.

The affection of the brain in apoplexy, being, in the majority of cases, attended with an effusion of blood into the substance of the organ, in the ventricles, or between its membranes, the term cerebral hæmorrhage has been proposed by some writers as a more definite and appropriate appellation, and by others the term apoplexy has been extended to all effusions of blood into the texture of the different organs of the body, especially into the lungs; hence, the expressions pulmonary and cerebral apoplexy are in common use.

From the earliest periods, the phenomena attendant upon an attack of apoplexy have very forcibly arrested the attention of the medical profession. The disease is distinctly noticed by Hippocrates, under various points of view, and it is decribed by the Greek, Roman, and Arabian physicians with a degree of minuteness and accuracy that have scarcely been exceeded in modern times. As might however be expected, from their ignorance of the structure and functions of the brain and nervous system generally, the notions of the ancients in regard to the pathology of apoplexy were confused and altogether absurd. It was not until about the seventeenth century that the morbid appearances discovered in the brains of those

who died after an attack of the disease, were studied with any degree of care; and to the accounts of those appearances, furnished to us by the medical writers of that, and the first part of the succeeding century, but little has been added by the laborious researches of subsequent pathologists. In the first six or seven epistles of the work of Morgagni (*De Sedibus et Causis Morborum,*) will be found some very interesting notices of the autopsical investigations of apoplexy by the physicians of the period just referred to. It is only, however, very recently, that the real character of the lesions of the brain revealed by dissection and the relation which exists between them and the symptoms which characterize the disease have been accurately examined, and an approach has been made towards a correct theory of its nature and causes: it is nevertheless true, that upon many points connected with its pathology we still remain in entire ignorance.

Description of the disease. Although in the majority of cases the invasion of apoplexy takes place suddenly, while the patient is apparently in a state of perfect health, yet, in numerous instances, particularly in a first attack, it is preceded, for a longer or shorter period, by certain symptoms which indicate the existence of more or less irritation and congestion of the brain. These symptoms are pain, or a sense of weight and fullness of the head, ringing in the ears, vertigo, a tendency to sleep, flushing of the face, a turgescence of the jugulars, a throbbing of the carotid and temporal arteries, suffusion of the conjunctiva, sparks and flashes before the eyes, temporary blindness, particularly in a stooping position of the body, imperfection or loss of hearing, and a sense of numbness or formication in different parts, especially in the extremities. These symptoms are occasionally relieved, either partially or completely, by a discharge of blood from the nostrils, and the apoplectic attack is suspended for a season, or entirely prevented. In other cases, in addition to the foregoing premonitory symptoms, slight convulsive movements of the muscles are observed, with involuntary grinding of the teeth, loss of memory, stammering or imperfect articulation; sometimes confusion of ideas, indicated by incoherent discourse; disturbed sleep, hurried respiration, a feeling of weight or of uneasiness at the precordia. In many instances, the disease is ushered in by nausea and vomiting. It is proper, however, to remark that no one of these symptoms is found to precede the occurrence of apoplexy with any degree of constancy. In very many cases they are all of them entirely absent, while the majority of them frequently take place without being followed by an apoplectic fit. Of sixty-nine cases of apoplexy, of which Rochoux has collected the histories, eleven only presented any precursory symptoms, and in five of these, the patients had been habitually subject to vertigo, which was not sensibly augmented previously to the occurrence of the disease; hence, he remarks, correctly speaking, in six of the patients, only, the precursory symptoms were present. (*Recherches sur l'Apoplexie.*)

When seized with apoplexy, the patient falls down suddenly, and is deprived entirely of sensation, voluntary motion, and consciousness. Sometimes, however, the attack is less intense, and the patient retains some degree of consciousness, is still sensible to impressions, and capable, to a certain extent, of voluntary motion.

In other instances, the patient experiences suddenly a deep-seated pain in the head, tremor of the limbs, confusion of ideas, with pallor of the face, vertigo, and nausea or vomiting. These symptoms are soon followed by a state of insensibility, the patient being attacked as it were with syncope. From this he recovers, after a short period, so far as to be able to converse, and perhaps to walk about, but still complains of pain and uneasiness of the head, with confusion of mind and vertigo. In the course of a few hours, he again sinks gradually into a state of complete stupor.

In other cases, the patient becomes suddenly affected with a paralysis of one side of his body, attended with loss of speech, pain of the head, vertigo, and dullness or confusion of ideas; but the sensorial powers and consciousness still remain. By degrees, however, these become extinct, and a state of complete apoplectic stupor finally ensues.

During a fit of apoplexy, the patient lies in a state of coma, more or less complete. The face is commonly of a deep red or livid hue, and puffed up or swollen; in some instances, however, it is pale, and the features appear shrunk. According to Rochoux, (*Op. Citat.*) one of the most constant symptoms attendant upon apoplexy, is a kind of stupid or vacant expression of the countenance. Not unfrequently the muscles on one side of the face are drawn in such a manner as to give to the features a kind of sardonic grin. The surface of the body and the extremities, either re-

tain their natural temperature, or are cold and clammy; in some cases the whole surface of the body becomes covered with a profuse perspiration, which may be either warm or cold. According to Dr. GREGORY, the occurrence of a cold clammy sweat is almost always a fatal symptom. (JOHNSON. *Med.-Chirurg. Review*, Vol. I. 1820.) The teeth are firmly clenched, and the power of deglutition is either impeded or destroyed.

The pulse may be slow, full and hard, or small and feeble. In perhaps the majority of cases the pulse will be found at first to be regular, strong, full and slow, but as the disease advances, it becomes weaker and more frequent; and, finally, irregular or intermittent. The pulse being at first small, and afterwards becoming very full, Dr. GREGORY considers a fatal indication. LANDRÉ BEAUVAIS pronounces, also, a strong, hard and full pulse, to be indicative of great danger, as we have then to fear a continuance or quick return of the hæmorrhage from the vessels of the brain. In extreme cases, in which death takes place within a very short period, the pulse from the beginning of the attack is imperceptible, or nearly so,—the heart appearing to be paralyzed in common with the voluntary muscles.

The eye-lids are commonly half unclosed; the eyes are injected with blood, or they are dull and glassy; in general, the ball of the eye is fixed; in many cases, however, it is observed to roll about in its socket. In most instances the pupils are dilated; one pupil may, however, be dilated, while the other is contracted; the pupils sometimes dilate and contract alternately, with great quickness, and, as it were, spasmodically, without being influenced by the stimulus of light. In a few cases, the pupils, in place of being dilated, are contracted almost to a point. This condition of the pupils, though pointed out long ago by ARETÆUS, and more recently noticed by CHEYNE and COOK, seems to have escaped the attention of most writers on the disease. Dr. COOK considers it to be among the most fatal symptoms; never having known a patient to recover, in whom it was observed. (*Treatise on Nervous diseases.*)

The respiration is slow and irregular, and in most cases, it soon becomes stertorous; but occasionally, the breathing is perfectly natural. The presence or absence of stertorous breathing was supposed by BOERHAAVE, PORTAL, and by many of the more recent writers, to furnish an invariable indication of the intensity or mildness of the attack. Such, however, is not the fact. In many patients, the breathing is very laborious, and yet complete recovery quickly ensues; while in others, an almost natural state of the respiration may accompany an attack, which terminates rapidly in death. In the more violent cases of apoplexy, expiration is often attended by a puffing motion of the lips, as in smoking a cigar; and a frothy saliva is blown out with a sputtering noise.

The bowels, during the continuance of apoplexy, are generally torpid; but occasionally an involuntary discharge of their contents takes place. This generally depends upon a paralysis of the sphincter ani, and is to be considered a very unfavourable symptom. (CRUVEILHIER. *Anat. Pathologique.*) The urine is very frequently discharged involuntarily. In some cases, however, from paralysis of the bladder, the urine is retained. This, likewise, is considered an unfavourable circumstance. (ROCHOUX.) Although, during an apoplectic attack, the whole body is affected with a loss of sensation and of voluntary motion, this loss is most frequently observed to be more considerable on one side than on the other; and, in such cases, when the patient recovers from the comatose state, it will be found, very generally, that the muscles on the side most affected remain completely paralyzed. The muscles of the extremities, on one side of the body, are now and then, during the fit, affected with slight convulsive movements.

The duration of the apoplectic stupor varies from a few hours to many days. Death may occur in the course of a few hours, without the patient recovering from the state of coma. In this case, the stupor becomes more and more intense; the pulse small, irregular and frequent, and the respiration slow, short, and interrupted by long intervals. Cases of instantaneous death from apoplexy are extremely rare; life being seldom destroyed before the termination of three or four hours. (ROCHOUX.)

When the case terminates favourably, the symptoms slowly and gradually abate, and the patient regains finally his ordinary state of health; or, as more frequently happens, the stupor disappears entirely, but the muscles of one side of the body, or of a particular part, remain paralyzed, and may either continue in this condition for life, or, under an appropriate treatment, regain gradually their powers. In some instances, as the apoplectic symptoms disappear, those of cerebral inflammation present themselves, attended with more or less of increased action of the general circulatory system. In other cases, the apoplectic seizure is succeeded by extensive para

lysis; the affected limbs becoming greatly emaciated, while the faculties of the mind are much impaired; the patient laughing or crying when spoken to, without any assignable cause, and apparently without any motive. (Rochoux.)

After all cases of apoplexy there is a disposition to a recurrence of the disease; the number of attacks, and the period of their recurrence, being uncertain. In most instances the patient is sooner or later destroyed, or remains a helpless paralytic for life. Many survive a considerable number of slight attacks, but the more severe commonly prove fatal on the second or third occurrence; thus verifying, in some degree, the popular remark, that the third attack of apoplexy always kills the patient. (Clutterbuck. *Cyclopædia of Pract. Med.*)

Predisposing Causes. Apoplexy is almost invariably a disease of advanced life, seldom occurring before the forty-fifth or fiftieth year. No age, however, is exempted from it; but, in young persons, it is more commonly induced by what may be termed mechanical causes; or, it comes on in them gradually, and not, as in those of more advanced years, by a sudden and unexpected stroke. Hippocrates (*Aphorismi.* Sec. VI. 57.) has laid down the period between the ages of forty and sixty, as that when the occurrence of the disease is the most frequent. From later observations, however, it has been shown, that it attacks as frequently, if not more so, beyond as within this period. Of thirty cases which fell under the notice of Morgagni, seventeen were in persons above the age of sixty, and but five in those below forty years of age. Rochoux gives a table of sixty-nine cases; of which thirty-seven, or more than half, occurred after the age of sixty years; twenty between forty and sixty, and the remaining twelve between twenty and thirty. The fact of the more frequent occurrence of apoplexy after the age of sixty, than at any other period of life, is stated by Cullen, and repeated by Portal. (*Obs. sur l'Apoplexiè.*) It is not, however, confirmed by the bills of mortality for Philadelphia and its suburbs. These give 577 deaths from apoplexy during the ten years, ending on the first of January, 1835; of which, 197 were in persons beyond sixty; 209 in those between forty and sixty; 142 in those between twenty and forty, and 29 in those below twenty years.

Apoplexy is of more frequent occurrence in the male than in the female sex; probably from the former being much more addicted than the latter to excesses, both as it regards the body and the mind. Of 51 apoplectic patients, admitted into the General Hospital of Hamburg, during the years 1828 and 1829, fifteen only were females. In Berlin, in the year 1829, of 699 deaths from apoplexy, 409 took place in males, and 290 in females. In Philadelphia, during the three years preceding 1835, the number of deaths from apoplexy was 209; of these, 119 occurred in males, and 90 in females. M. Serres, however, found, that to the particular form of apoplexy, denominated by him *meningeal*, (that is, apoplexy without paralysis,) females are much more liable than males. Out of forty-one cases, of this species, which fell under his notice, thirty-three were in females, and only eight in males. And the registers of the Salpêtrière and Bicêtre make the predominance still greater on the side of the female sex.

Persons of a plethoric habit of body, with a large head, short thick neck, florid complexion, broad shoulders, low stature, ample chest, globular abdomen, and general inclination to obesity, are those most predisposed to apoplexy. These features constitute what Bricheteau denominates the apoplectic form. "If with these (says Bombier) are associated those habits which make the head a centre of excitement for vascular fluxion, at the same time that the other organs are left inactive, the sensorial functions acquire a remarkable predominance in strength and activity; but too often to the destruction of the individual. This is frequently exemplified in the persons of such as give themselves up to immoderate study, uninterrupted by a sufficient quantum of sleep and muscular exercise." (*Considerations et Observ. sur l'Apoplexie.*)

Most writers agree with Cullen in considering excessive obesity among the predisposing causes of apoplexy, in consequence of its impeding the free passage of the blood through the lungs. In the 69 cases detailed by Rochoux, the majority, nevertheless, (namely, 42) occurred in subjects presenting no remarkable degree of obesity; 10 only were in fat and plethoric subjects, and 17 in meagre subjects.

A sedentary and inactive life, with a full nourishing diet; too great an indulgence in sleep; venereal excesses, especially in those advanced in years, and a change from an active or laborious to a quiet and indolent mode of life, are well-known predisposing causes of apoplexy. A predisposition to the disease is likewise produced by intense thought, prolonged study, or by

the habitual indulgence in any of the more absorbing passions or affections of the mind. The influence of a meditative and studious life, in the production of the disease, is evinced, according to PONSART, by a much greater number of monks and financiers becoming apopletic than of peasants. While we admit, however, the injurious effects resulting from too intense and prolonged an application of the mind, to the neglect of bodily exercise, we conceive the remark of ROCHOUX to be fully substantiated by facts; namely, that intellectual pursuits, generally speaking, so far from predisposing to apoplexy, are rather a preservative from the disease.

It has been remarked, that apoplexy is frequently brought on by the sense of deep chagrin and mortification, which an ambitious and proud mind experiences when it fails in attaining some much cherished object, or suffers a great and unexpected reverse of fortune. Thus FOURCROY was seized with apoplexy, in consequence of the cruel mortification which he experienced in not being named Grand Master of the Imperial University; and the same occurred to CHAUSSIER, when he was deprived of his chair of professor in the faculty of medicine at Paris.

According to HIPPOCRATES, and the majority of the Greek physicians, cold and moisture, or sudden atmospherical vicissitudes, are to be ranked among the predisposing causes of apoplexy. A similar statement is also made by BAGLIVI, FORESTUS, MORGAGNI, RICHTER, and most subsequent writers on the disease. ROCHOUX, however, doubts the fact of season, climate, or atmospherical vicissitudes, having any influence in its production. In the 69 cases of which he collected the histories, 16 occurred in spring, 19 in summer, 18 in autumn, and 16 in winter. An increased temperature of the atmosphere would, certainly, appear more frequently to predispose to apoplexy than the opposite condition. Thus, according to FRANK, (*Prax. Med. Univ. Præcep.* I. 308.) apoplexy occurs most frequently at Wilna and St. Petersburgh during the greatest heats of summer. Exposure to extreme degrees of cold has undoubtedly a tendency to induce a kind of apoplectic sleep, from which the person seldom, if ever, awakes; but this condition can scarcely be considered as identical with apoplexy.

Agreeably to the observations of QUARIN, apoplexy is much more common in cities than in the country. This might readily be anticipated, when the life and condition of the agricultural classes, generally speaking, are contrasted with those of nearly every class of citizens.

Of all the predisposing causes of this disease, none, perhaps, is more general or efficient than the habitual indulgence in distilled, vinous, or malt liquors. "The daily use," remarks CHEYNE, "of wine or spirits, even in what is considered a moderate quantity, will lead a man of a certain age and constitution to apoplexy, as certainly as habitual intoxication;" and he adds, "in nineteen cases out of twenty, the disease may be averted or postponed by temperance."

A state of pregnancy is considered by MENIERE (*Archives Gen. de Méd.* XVI. 489.) as predisposing to apoplexy. But, as ROCHOUX very properly remarks, this is disproved by the disease more frequently occurring after than before the fortieth year, consequently subsequent to the period when pregnancies are most common. There is no doubt, however, that, during the puerperal state, females are in some degree predisposed to apoplexy. Dr. DAVIS, of London, states that he has met with four or five apoplectic attacks followed by hemiplegia in puerperal females. In all these cases, the patients presented the true apoplectic phenomena.

The poor are equally liable to the attacks of apoplexy as the rich. Sir GILBERT BLANE has even observed, from accurate tables, derived from a practice of ten years in St. Thomas' Hospital, London, and his private consultations, that there is a considerably greater proportion of apoplexies and palsies among the poor than among those in affluent circumstances; or, in other words, that these diseases bear a larger proportion to other maladies among the poorer classes, than among those in high life. "Some cases of hemiplegia," he observes, "occur in full habits; some in spare and exhausted habits. The former, being most incident to the luxurious and indolent, more frequently occur among the upper ranks of life. The latter occur more among the impoverished classes, and among such of the rich as are addicted to exhausting pleasures." (*Trans. Medico-Chirurg. Soc.* IV. 124.)

Various diseased conditions of the heart, especially hypertrophy, have been found to predispose the individuals in whom they occur to an attack of apoplexy. This fact is attested by LE GALLOIS, PARISET, CORVISART, TESTA, BERTIN, HOPE, CRUVEILHIER, and others. In support of it, a series of very interesting observations are presented by BRICHETEAU and RAVIER. (*Journ. Complém.* IV. 17. *Thèses de Paris.* 1821.

No. 14.) According, however, to Lallemand, when, in addition to the hypertrophy of the heart, there exists also any obstacle to the free passage of the blood into the aorta, the tendency to an apoplectic seizure will be prevented. Of forty-two apoplectics, whose bodies were examined after death by Rochoux, three only presented an aneurismal condition of the heart. But Andral is of opinion, that these dissections cannot be adduced to disprove the fact of the intimate connexion between disease of the heart and apoplexy; hypertrophy, with diminished size of the ventricular cavities, being a disease that was but little known at the period when they were performed, its existence may have been overlooked in some of the cases. Richond conceives that both the disease of the heart, and that of the brain, when they are found to coexist, are to be referred to one and the same cause, an irritation, namely, of the mucous membrane of the stomach.

Nearly all the chronic affections of the brain may be ranked among the predisposing causes of apoplexy. Thus in epilepsy, chorea, and certain forms of mania, death is frequently caused by the occurrence of an apoplectic attack. But among those morbid conditions of the brain, which most frequently predispose to the occurrence of apoplexy, is a diseased state of its vessels, consisting in a peculiar friability or brittleness of their coats, from a calcareous deposit, to a greater or less extent, into the tissues of the latter. This condition of the vessels, the tendency of which to induce aneurism and hæmorrhage has been clearly demonstrated by Scarpa, is very commonly met with in the brains of elderly persons; and its agency in the production of apoplexy, is pointed out by Cruveilhier, Abercrombie, and other writers on the disease.

Wepffer, Forester, Dreysig, Portal, Frank, Van Hooven, Blane, and others, adduce numerous cases of apoplexy, falling under their own notice, which seem to show that the disease, in many instances, must be considered to be an hereditary affection. Several striking instances, of a similar character, have come within our own knowledge. The general fact is, however, denied by Rochoux. But we believe there can be little doubt that the peculiar conformation and habit of body which predispose to apoplexy, may be transmitted in particular families; and this is all that is meant when the disease is said to be hereditary.

According to Baglivi, apoplexy has occasionally prevailed epidemically. The same fact is also stated by Morgagni, Hoffman, Richter, Weikard, Jahn, Thilenius, and others. (Richter. *Specielle Therapie.* VIII.)

Certain professions or occupations are said unquestionably to predispose to the disease; particularly such as expose the individuals engaged in them to the inhalation of metallic and other deleterious gases.

Exciting Causes. The continued action of many of the predisposing causes already enumerated, will often be sufficient of itself to induce an attack of apoplexy. Thus, not unfrequently the patient is seized in the midst of his ordinary occupations, even when not subjected to any unusual fatigue or exertion. In other cases the attack takes place during sleep, or when the patient is conversing with the utmost calmness, and without, apparently, the brain or heart experiencing any unusual excitation. But there are certain causes by which apoplexy may be produced, to the influence of which the patient is subjected only a short time before the occurrence of the disease. It is to these the term exciting causes is most generally restricted. The latter, however, will seldom cause an attack unless the brain is already predisposed to disease. Among these causes may be enumerated whatever has a tendency to impede the free return of the blood from the head; to produce a sudden or violent excitement of the mind, or to induce irritation of the brain, or of its membranes, either directly or indirectly. Thus the disease is frequently brought on by wearing tight clothing, especially such articles of dress as press upon the vessels of the neck, or impede the free expansion of the chest; by an overloaded condition of the stomach; by violent straining, particularly in lifting heavy weights; by blowing wind-instruments, or any other cause by which the free passage of the blood through the vessels of the lungs is, for a time, prevented. Tumours in the neck, pressing upon the jugular veins, obliteration of the latter, from inflammation of their coats, as well as obliteration of the occipital, parietal, and mastoidian veins, by which the communication between the external and internal veins of the cranium is destroyed, are considered by Morgagni, and, more recently, by Cruveilhier, to be not unfrequently causes of apoplexy. Cullen enumerates among the exciting causes of this class, stooping down, with the head towards the ground, and other situations of the body in which the head is kept for some time

in a depending position. According to Portal, tumours of considerable size, within the abdomen; and ossifications of the thoracic and ventral aorta, as well as of the arteries of the extremities; of the superior cava, or of the right ventricle and valves of the heart, by the impediment they present to the free circulation of the blood, act occasionally as exciting causes of apoplexy. (*Resultes de l'overture des corps.*) The agency of some of the above circumstances, in the production of the disease, will admit of considerable doubt; while it is probable that others of them produce an attack, not as is generally supposed, merely by inducing, mechanically, venous congestion of the brain, but by causing irritation of some portion of its substance, or of its membranes.

The exciting causes of apoplexy, which act by producing a sudden or powerful impression upon the brain, are fright, excessive joy, a violent fit of anger, the venereal orgasm, or any powerful shock to which the feelings may be unexpectedly subjected.

Among the causes which bring on an attack of the disease, by causing irritation of the brain or of its membranes, directly or indirectly, is, intemperance in eating and drinking. Sir A. Carlisle presents a case of apoplexy, caused by the drinking of an immense quantity of gin, the odour of which was detected, on inspection, in the serum of the ventricles of the brain. Wepffer (*Obs. Medico-Prac.* Page 7. 1722.) and Schroder (*Obs. Anat. Med.* Decad. IV. 1674.) relate similar cases. The fact is, the condition of the brain, as well as the external phenomena produced by extreme inebriation, so nearly resemble what takes place in apoplexy, that it is very difficult, in many cases, to distinguish the one from the other. In general, however, the application of some powerful irritant to the skin, as sinapisms or the actual cautery, will quickly rouse the inebriate, but will have very little effect upon the individual affected with apoplexy. From a state of complete intoxication, induced by large quantities of ardent spirits, many individuals never recover; death being produced by a true apoplectic seizure. Apoplexy may likewise be brought on by late suppers, particularly of stimulating and indigestible food. According to Portal and Rochoux, the disease is found to be of much less frequent occurrence in Paris since the practice of eating heavy suppers has been relinquished. Among the other exciting causes which act chiefly upon the brain, are, exposure to the direct rays of the sun; falls or blows upon the head; concussion or wounds of the brain; violent exercise, particularly in warm weather; breathing a heated and impure air, as that of crowded apartments. It is well known that this cause will produce intense pain of the head, and a sense of over-fullness in the vessels of the brain, even in persons not predisposed to apoplexy. Erysipelatous affections of the face and scalp; repelled eruptions; the sudden cessation of any habitual discharge, especially that arising from hæmorrhodes; and of the frequent (sometimes periodical) flow of blood from the nose, to which plethoric subjects are occasionally liable. According to Schmucker, Cruveilhier, and others, the healing up, without proper precaution, of old ulcers has also a tendency to produce an attack of apoplexy in the predisposed; and Vogel has noticed a similar effect from the neglect of customary venesection in persons of full habits. The truth of this is confirmed by Cruveilhier.

Apoplexy is likewise not unfrequently brought on by the incautious treatment of long-continued discharges from the ears, causing their sudden stoppage. Inflammation has also been known to extend, in cases of violent otitis, from the internal structure of the ear to the brain, and in this manner, give rise to apoplexy. Instances of this are related by Lallemand, Gendrin, Itard, Krukenberg, Copland, and others.

The most frequent, however, of the exciting causes of apoplexy, is unquestionably irritations of the gastro-enteric mucous membrane. Many of the causes already enumerated exert evidently their morbid effects first upon the stomach and small intestines, from which organs the irritation excited by them is subsequently transmitted to the brain. This is especially the case in reference to intemperance in eating and drinking, the use of indigestible food, a too free indulgence in condiments, and other stimulants; a sedentary, indolent, and luxurious mode of life, &c. And it is by exciting irritation of the stomach and bowels, or by augmenting that which already exists, that the use of certain mineral waters, and other irritating remedies, as emetics, purgatives, tonics, and the like, are too often fatal to persons predisposed to apoplexy, or labouring under some degree of paralysis. The connexion between irritations of the stomach and apoplexy was not entirely overlooked by former writers. It is noticed, among others, by Baglivi, Schroder, Barthez, Schaffer, Tissot, Schenk, Fothergill, Hoff-

MAN, THILENIUS, VAN SWEITEN, and more recently, by HUFELAND, LOUYER, FODERÉ, VILLERMAY, and CHOMEL; but it is chiefly to the writings of BROUSSAIS, and the very excellent treatise of RICHOND, (*De l'influence de l'Estomac sur la production de l'Apoplexy*,) that we are indebted for the full establishment of the fact, and the important indications which it presents in the prevention and treatment of the disease. It is by the tendency of the brain to suffer from irritations primarily seated in the digestive canal, that we are to explain the liability to apoplexy of persons labouring under hepatic disease, noticed by STOLL, BALDINGER, CHEYNE, COPLAND, TIVENINS, &c.; affections of the liver being almost invariably attended by very considerable gastro-enteric irritation; of which latter it is in fact often merely the sequel. In the same manner may also be explained the frequency with which apoplexy occurs in persons of what are termed a gouty diathesis. The brain may also occasionally suffer from external irritations. Thus metastasis of rheumatism, in particular, will often produce an apoplectic attack. Cases of this kind are related by MORGAGNI, HOFFMAN, WIEKAND, STOLL, VILLENEUVE, and a number of other writers.

Apoplexy sometimes occurs during the severe and protracted chill with which certain forms of intermittent fever are occasionally attended. In such instances, the apoplectic seizure is said to be, in general, comparatively light, and neither attended with nor followed by paralysis. Though, as a general proposition, this statement may be correct, yet cases do occasionally occur in which the attack is so intense as to produce almost immediate death; and COPLAND refers to an instance that fell under his own notice, in which paralysis supervened upon the apoplectic seizure. (*Dict. of Pract. Med.* London, 1833.)

The association of apoplexy with disease of the kidneys has been noticed by several writers, particularly BONET, LITTRE, MORGAGNI, and BRIGHT. The occurrence of apoplexy, particularly that form attended with serous effusion in the brain, after suppression of urine, is not uncommon. By some authors the suppression has been imputed to pre-existing disease of the brain. In a great majority of cases, however, the kidneys and ureters present evidence of having been the parts primarily affected. The experience of BONET and MORGAGNI, and of numerous late writers, would appear fully to support this conclusion. The occurrence of apoplexy, as a consequence of organic change in the secreting structure of the kidneys, by which their functions are more or less obstructed, has been fully illustrated in the cases reported by Dr. BRIGHT. (COPLAND.)

The influence of narcotics, in large doses, in the production of apoplexy, is noticed by various writers. GREGORY, however, doubts whether they can ever, with propriety, be considered as exciting causes of the disease. We cannot conceive that there can exist any just ground for doubt concerning the fact: we have ourselves seen, in more than one instance, an over-dose of opium produce all the symptoms of the disease, followed by death; the brain exhibiting, upon dissection, extensive congestion of its vessels, and in one case, extravasation of blood. COPLAND relates the case of a young man, who, shortly after incautiously chewing some seeds of the monk's-hood, was seized with a sense of numbness in the face, succeeded by complete apoplexy, from which he was recovered with great difficulty, but with paralysis of one side of his body, with which he was still affected when upwards of a twelvemonth had elapsed from the period of the attack. (*Dict. of Prac. Med.* p. 92.) Apoplexy has likewise been excited by the inhalation of carbonic acid gas and certain mephitic vapours. And we saw, in one instance, the disease produced by the inhalation of vitrolic ether; from which, however, the patient (a young female) was promptly recovered by the ordinary remedies.

Within a few years, the production of apoplexy has been attributed, in certain cases, to profuse hæmorrhage, or to the artificial abstraction from the veins of large quantities of blood. It is certainly a curious fact, established, some time since, by the observations of SAUNDERS, SEEDS, and KELLIE, upon animals bled to death, that the brain will very often present a loaded state of its vessels, and more or less serous effusion into its ventricles, even in cases in which the patients have been destroyed by excessive loss of blood. But whether, in any case, a congestion of the brain can be produced in this way, sufficient to give rise to an actual attack of apoplexy, is very doubtful. Patients, we are told by Mr. HALL, who has written the most extensively on this subject, are sometimes so comatose after profuse blood-letting or hæmorrhage, that it may be doubted whether the case be not one of apoplexy. But we conceive that the line of distinction, between such cases and

genuine apoplexy, is clearly and strongly marked. Nevertheless attacks of apoplexy have indisputably occurred after extensive losses of blood. Thus DENMAN relates an instance, in which a female, who was greatly exhausted in consequence of repeated hæmorrhage from a fungous tumour of the uterus, was suddenly seized with apoplexy. HAY also, in his work on puerperal fever, cites the case of a female, who, after being relieved of that disease by free and repeated bleedings, became affected with symptoms of cerebral congestion, followed by permanent paralysis. Dr. TWEEDIE states that a female, who was much exhausted by frequent and profuse hæmorrhage from the uterus, during the last months of pregnancy, when first permitted to sit up, after delivery, became paralytic on the right side. The paralysis gradually disappeared; but, during a journey to Brighton, she suddenly became insane. A case is likewise given, by Mr. HAMMOND, of a parturient female, who lost about three pints of blood after the expulsion of the placenta. Subsequently she became affected with severe pain of the head; for which she was bled, cupped, and purged very freely. The bleeding was carried at one time to the extent of twenty-four ounces, and was afterwards repeated to the amount of twenty-two ounces, when fainting was induced, and the patient became strongly convulsed. On recovering, the head-ache appeared to be relieved; but again returning, was treated by two applications of leeches to the head. On the eleventh day, subsequent to confinement, she became paralytic on the right side, and her voice and deglutition were impaired. By the end of the month, however, she was quite convalescent. These cases, and many others of a somewhat similar character that might be cited, prove, we admit, that apoplexy and paralysis may occur in patients whose general system is in a state of extreme exhaustion, from loss of blood, or other evacuations; but they by no means establish the fact, that the disease of the brain upon which the apoplectic attack depends, is the immediate effect of the depletion to which the patients had been subjected. We are not, therefore, prepared to admit extensive losses of blood among the exciting causes of apoplexy.

Anatomical Lesions. As would be anticipated from the character of those phenomena which more particularly characterize the disease, on examining, by dissection, the bodies of apoplectic patients, after death, it is in the brain that morbid appearances are the most constantly observed. Other organs, it is true, often present indications of more or less disease; but, as these are very frequently met with in patients who have not suffered from apoplexy, and are as frequently absent in those who have, they may be considered either as not at all connected with the apoplectic seizure, or, at least, as having only an indirect influence in its production.

After death, from apoplexy, the brain is said, in a few cases, to be found in a perfectly natural state, and presenting no indications whatever of its having been recently the seat of disease. Such instances are related by WILLIS, STARK, POWEL, ABERCROMBIE, FODERÉ, HILDENBRAND, and others. They are, however, we suspect, of extremely rare occurrence. Of seventy-six fatal cases of apoplexy, related in the work of BONETUS, (*Sepulchretum*), all presented evident disease of the brain, with the exception of one only; and in that the relater even doubts whether the death of the patient could be attributed to apoplexy. In all the cases reported by MORGAGNI, in which the brain was examined by himself, more or less disease of that organ was present. JOHN HUNTER asserts, that in all the cases he had an opportunity of examining, after death, there existed an extravasation of blood in the brain. PORTAL found, in all his dissections, congestion of the vessels of the brain, with or without effusion of blood or serum. CHEYNE makes a similar statement. Dr. GEORGE FORDYCE examined the brains of ninety-eight apoplectics and paralytics, and discovered effusion of blood in all. BAILLIE likewise noticed effusion of blood in the brain in all the cases examined by him. SERRES dissected the brains of a hundred apoplectics: in all, evident marks of disease were present. But it is unnecessary to enlarge upon this point. We need only refer to the writings of LALLEMAND, BRICHETEAU, ROCHOUX, CRUVEILHIER, and ROSTAN, for proof of the almost invariable occurrence of a morbid state of the brain in those who have been destroyed by apoplexy. In some of the cases in which no morbid appearances are reported to have been detected after death, it is probable, as BRICHETEAU very justly remarks, that the lesion of the brain has been actually overlooked; while in others, it is possible, that at the moment of, or subsequent to death, the engorgement of the cerebral vessels, giving rise to the disease, was dissipated.

The post-mortem appearances, ordinarily detected in the brains of apoplectics,

may be arranged under five general heads. 1. Congestion of the vessels of the brain and of its membranes; 2. Effusion of blood without any lesion of the substance of the brain; 3. Effusion of blood with rupture or disorganization of the substance of the brain; 4. Effusion of serum; 5. Various diseased conditions of the membranes of the brain, or of the latter, with or without effusion of blood or of serum.

1. *General turgescence of the vessels of the brain.* Cases of this kind are related by Morgagni, Cheyne, Bricheteau, Richter, Serres, Foquier, and others. The vessels and sinuses of the dura mater, the vessels upon the surface of the brain, and those of the dura mater, are found in many cases unusually distended with blood, and occasionally more or less of a bloody infiltration into the substance of the latter can be detected, but unattended by effusion of blood, strictly speaking, or by any appreciable lesion of the brain itself. When, however, incisions are made into the latter, the cut surfaces are found to be studded with numerous small points of blood, indicating, evidently, an unusual fullness of the vessels which penetrate into the substance of the organ. This engorged state of the cerebral vessels is almost always attended by an engorgement, more or less extensive, of the vessels of the scalp and neck; and not unfrequently large ecchymoses exist about the throat and chest.

In cases of apoplexy accompanied with general turgescence of the vessels of the brain, according to the observations of Bricheteau, the coma is more intense, and the abolition of the intellectual faculties more complete, than in those attended with effusion of blood. The condition of the brain above described, is met with in few, comparatively, of the autopsical examinations of apoplectic subjects, and the reason is, that it constitutes the least fatal of all the species of apoplexy—the number of the patients affected with this congestive form of the disease who recover, according to the author last quoted, being much more numerous than those who die. In many instances, however, death ensues very promptly.

In the work of Morgagni, several cases are related of apoplectic attacks almost immediately fatal, in which, after death, the principal lesion discovered in the brain was extensive engorgement of its vessels. This was the case, more especially, in the instances related in *Epis.* 3, sec. 26, *Epis.* 4, sec. 16, 21, 24, 32, and in *Epis.* 5, sec. 19. Foquier relates a somewhat similar case in the *Ann. Med. Chirurg.* I. 376; and the ninety-fifth case of Abercrombie (*Diseases of the Brain and Spinal Cord*) was evidently one of the same kind.

2. *Effusion of blood without any lesion of the substance of the brain.* In cases of this description, the blood is generally extravasated between the dura mater and arachnoid, and may be produced either by exhalation from the capillary vessels of the membranes, or by rupture of one or more minute arteries or veins. Instances are recorded in which the blood appeared to be derived from the retiforme plexus of vessels at the basis of the brain, and was confined beneath the pia mater. Bonetus relates a case in which a very extensive effusion of blood existed between the pia mater and the brain, and throughout the whole extent of the vertebral canal. The blood in this case came from the small arteries surrounding the basis of the brain, which are given off from the carotids and vertebrals. In a case reported by Morgagni, a great quantity of blood was found in a coagulated state beneath the arachnoid, upon the anterior surface of the brain; both ventricles also contained a small quantity, partly fluid and partly coagulated. M. Rochoux reports a case of very extensive effusion upon the surface of the brain, from the rupture of some of the superficial vessels of the latter. Two cases are likewise given in the work of Abercrombie, in one of which, reported by Dr. Barlow, a copious extravasation of blood was found extending over the surface of the brain, and closely adherent to the dura mater; and in the other, reported by Dr. Hunter, a coagulum of blood covered and completely concealed the right hemisphere of the brain, and dipped down below its basis. In both instances, the blood appears to have been thrown out by exhalation. Richter, also, states that he has occasionally found extensive extravasation of blood beneath the membranes of the brain, but makes no mention of a rupture of any vessel, or any evident disease of the brain itself. In a case recorded by Bang, (*Act. Reg. Soc. Med. Havn.* I. 116.), and in another by Dr. Watts, of New-York, (*Med. Surg. Regis. of N. Y.*), the blood was effused between the cranium and dura mater. Effusions of blood thus situated are frequent in apoplexies produced by external injuries of the scull. (*Specielle Therapie.* VIII. 719.) In those cases in which the hæmorrhage proceeds from rupture of an artery, all the superficial vessels, according to Serres, are found greatly distended, while a twig or branch is torn partially or quite across. More rarely

he has found a small aneurismal pouch ruptured in the same manner as an aneurism occurring in any other part of the body. He has also seen the internal carotid aneurismal and ruptured, while yet inclosed in the cavernous sinus; and subsequently he met with an instance in which the aneurism occurred in the basilary artery, and in a small artery in the circle of WILLIS. Cases of a similar kind are related by various other writers. The hæmorrhage upon the surface of the brain is sometimes caused by ulceration of the coats of an artery. Dr. MILLS relates a case in which it was traced to ulceration of the basilar artery; and MORGAGNI one, in which it arose from a similar lesion of the internal carotid: ulceration was likewise the cause of the hæmorrhage in the case of Dr. WATTS noticed above. Extravasation of blood from rupture of the veins is still more frequent, according to SERRES, than from rupture of an artery. The venous rupture occasionally takes place in the choroid plexus, and the blood is inclosed in a thin cyst, or between the laminæ of the pia mater. Cases in which the hæmorrhage was traced to the vessels of the choroid plexus are likewise related by MORGAGNI, DE HAEN, HUFELAND, and CRUVEILHIER. This is probably the source of the effused blood when it is confined to the ventricles, without laceration of the surrounding substance of the brain. Blood, however, is rarely effused, in the first instance, into the ventricles. During ten years' observation in the different hospitals, BRICHETEAU saw only two instances of this: in these there was no rupture of the parietes of the ventricles, nor of any vessel, the blood being thrown out by exhalation. In general, when the ventricles contain blood, it has been extravasated in their immediate neighbourhood, and bursts into them through a ragged opening. A very interesting case of extensive hæmorrhage into the ventricles, without lesion of the brain or rupture of vessels, is given by ABERCROMBIE.

Rupture of one of the lateral sinuses has been observed as the source of the hæmorrhage upon the surface of the brain: a case of this description occurred to Dr. DOUGLAS. (*Edin. Med. Essays and Obs.* V. 602.)

3. *Extravasation of blood into the substance of the brain, with rupture or disorganization of the substance of the latter.* This is by far the most common morbid appearance detected in the brains of persons destroyed by apoplexy. The blood is commonly extravasated in some part of the cerebrum, in the immediate vicinity of the ventricles, especially in the corpora striata and thalami optici. This fact was remarked by MORGAGNI, and is confirmed by the observations of subsequent investigators. Thus ROCHOUX, in forty-one dissections of apoplectic subjects, found twenty-six with extravasations in the corpora striata, and two in the thalami, while only thirteen, or not half the number, were found to be in various other parts of the brain. Of three hundred and eighty-six cases of apoplexy, with dissections, collected by ANDRAL from different writers, (*Anat. Patholog.* II. 758), two hundred and two presented extravasations of blood into both the corpora striata and thalami; sixty-one into the striated bodies alone; and thirty-five into the thalami alone: thus making two hundred and ninety-eight in which extravasation existed in this part of the brain. Of the remaining eighty-eight, in twenty-seven the extravasation was in that portion of the hemispheres which is situated above the centrum ovale of VIEUSSENS; ten in the anterior lobe of the cerebrum; seven in the posterior lobe of the cerebrum; nine in the mesocephalum; three in the peduncula of the cerebrum; one in the pituitary gland; one in the corpora olivaria; nineteen in different parts of the cerebellum; and eight in the spinal marrow. CRUVEILHIER has found the extravasation to take place frequently in the convolutions of the brain. SERRES describes a case in which it occurred in the substance of the pons varolii, whence the blood had burst into the occipital fossa. Extravasation of blood into the cerebellum is very rare. MORGAGNI reports only a single instance, (*Epis.* II. 22.), HEURTAULT relates a case, and BRICHETEAU saw a single instance at the Hôtel Dieu. The man died suddenly, and on dissection, a considerable effusion of blood was found in both lobes of the cerebellum. (*Journ. Compl.* Oct. 1818.) ABERCROMBIE met with it in two cases. ROCHOUX thinks it can scarcely occur once in fifty patients: in the cases reported by ANDRAL, it was found in about every 21.42 cases. The reason why extravasation should occur most frequently in the corpora striata, thalami, and their vicinity, results, according to BRICHETEAU, from the number of arteries which penetrate directly into those parts, without ramifying on the pia mater, as the other nutrient vessels of the brain do; and situated, consequently, in the midst of the cerebral substance, the consistence of which is little capable of supporting them

when over-distended with blood. (*Journ. Compl.*) In proof of this explanation, he remarks, that if injections are pushed with force through the carotids of young subjects, artificial extravasations will commonly be produced in this part of the brain, as was already noted by LALLEMAND. It is likewise, according to the observations of CRUVEILHIER, in the corpora striata or that vicinity, that the effusion of blood takes place, in cases of concussion of the brain. It was the opinion of MORGAGNI, that the effusion of blood in cases of apoplexy took place most frequently upon the right side of the brain. ROCHOUX, however, found that of forty-one cases which he examined after death, in twenty-four, the extravasation was on the left side; in twenty-four, on the right, while in seventeen, it occurred on both sides of the brain.

The blood, in whatever part of the brain extravasated, is contained in a cavernous pouch, which was compared by WEPFFER and MORGAGNI to an aneurismal sac. When the hæmorrhage is recent, the cavity in which the blood is accumulated has an irregular spherical form. Its parietes are torn and irregular; they present shreds of medullary matter, either completely detached and mixed with blood, or adherent by one of their extremities to the sides of the cavity. Surrounding the cavity, the substance of the brain is either perfectly healthy, stained with blood, or it is softened to the thickness of from half a line to two lines. It is sometimes converted into a reddish paste. This softened state of the brain in the vicinity of the extravasation, ROCHOUX considers to take place previously to the escape of the blood from the vessels; of which, according to him, it is the cause rather than the consequence; and he refers to BICHAT and HODGSON, in confirmation of the fact. CRUVEILHIER, on the other hand, maintains that it takes place subsequently, and is invariably the result of the infiltration of the blood into the substance of the brain.

The size of the cavity varies from that of a pea to one capable of holding several ounces of blood, and occupies nearly the whole of one of the hemispheres. When of considerable magnitude, it very generally communicates, by a rupture through the intervening medullary matter, either with the surface of the brain, the blood escaping into the cellular tissue beneath the arachnoid membrane, or with the ventricles. Frequently the septum lucidum is torn, and both the lateral ventricles become filled with blood; in some instances, the fornix, also, is torn; and occasionally, the apoplectic cavern and the lateral ventricles form but a single cavity. Most commonly, the thin membrane which closes the fourth ventricle is ruptured, and the more fluid part of the blood finds its way into the cellular tissue beneath the arachnoid of the spinal marrow as well as of the brain; occasionally, the arachnoid itself is torn and becomes infiltrated with blood. (CRUVEILHIER.)

If the patient be not immediately destroyed by the apoplectic attack, the extravasated blood coagulates; the serous portion infiltrating into the cellular tissue of the brain. This infiltration takes place almost immediately, when the apoplectic cavern communicates with the surface of the brain or with the ventricles; it takes place more slowly when the parietes of the cavern preserve their integrity. The infiltration into the substance of the brain, communicates to the medullary matter surrounding the extravasated blood a yellowish colour, which becomes gradually fainter in the parts of the brain more removed from the latter. This colour is generally perceived upon the third day of the attack, and is at its height by the eighth or eleventh; when absorption of the effused blood takes place with the greatest activity, and it is nearly deprived of all its serous portion. A short time afterwards, the yellow colour disappears; the coagulum of blood is reduced to a very hard and black nodule; is rapidly diminished in size, and finally completely absorbed. (CRUVEILHIER.)

While these changes are effected in the extravasated blood, the inner surface of the cavity in which it is contained becomes smoother and more even; the cavity itself contracts in size, assumes more of a spheroid form, its parietes become covered with numerous minute vessels, and it is soon discovered to be lined by a cellular structure, sometimes very delicate, and at others very dense, and as it were fibrous. As the coagulum of blood becomes daily lessened by absorption, the cavity diminishes still further in size, until at length its parietes touch, and become firmly adherent to each other. In other cases, the coagulum becomes inclosed in a perfect cyst, lined with a serous membrane of a yellowish colour, which exhales and absorbs as other tissues of the same class. The parieties in these cases never unite. These cysts were pointed out long since by BRUNNER, by BONETUS, and MORGAGNI; but it is to RIOBÉ that we are in-

debted for a correct description of, and just views in regard to them. He believes that the serous fluid exhaled by the lining membrane of the cyst, is useful by bathing and dissolving the contained coagulum of blood, and thus facilitating its absorption. (*Sur l'Apoplexie.* Paris, 1813.)

The absorption of the effused blood and the perfect cicatrization of the lacerated portions of the brain, in cases of apoplexy from which the patients have eventually recovered, is proved by the observations of numerous physicians, more especially by those of Rochoux, Riobé, Bricheteau, and Serres. Sometimes, when the apoplectic cavern has been small, the cicatrix is in the form of a hard knot of a fibrous consistence, which forms a strong contrast with the softness of the parts by which it is surrounded. According to Cruveilhier, this is the most frequent form of the cicatrix: sometimes, however, the latter has a linear appearance, as was first observed by Serres; this kind of cicatrix is the most rare. Whenever, either from the large size of the cavity, or from any other cause, the immediate contact of its parietes cannot take place, the latter cicatrize separately, and constitute a kind of ventricle within the substance of the brain. Most generally, the parietes are attached to each other by a loose cellular tissue; in other cases, as already remarked, a cyst is formed, lined with a serous membrane. The substance of the brain surrounding the cicatrix has either its natural consistence, or it is considerably increased in density for the thickness of one or two lines, or even more. Cicatrices are found in the brains of all subjects who during their life-time have been affected with paralysis consequent upon an attack of apoplexy, at whatever period death may have occurred. And their number always corresponds with the number of attacks. (Rochoux.)

The complete absorption of the effused blood is generally effected, and the cicatrization of the cavity containing it completed, according to Cruveilhier, by the end of the fourth or fifth month from the apoplectic attack. Riobé, however, found blood in the cavity twenty months after the apoplexy had occurred; Moulin, at the end of a year, and Serres, at the termination of even two and three years.

In certain cases of apoplexy, the extravasated blood, instead of being contained in a cavity formed by a rupture of the substance of the brain, is infiltrated into the latter, and is said to be combined with the medullary matter, which is in a state of disorganization. This peculiar condition of the brain, which Cruveilhier denominates capillary apoplexy or apoplectic softening, and considers to be identical with the red softening of the brain, so accurately described by Lallemand and Rostan, is evidently owing to the effused blood being collected in numerous minute cavities or foci. An example in proof of this, was recently presented to the Anatomical Society of Paris, by M. Tessier. (*Arch. Gén.* Jul. 1834.) The substance of the brain, to a certain extent, is reduced to a kind of pulp, and varies in colour, according to the quantity of blood effused, from a light rose to a deep red, purple, or even black. In some cases, the softened portion of the brain is not strictly circumscribed; but in others, it is so much so, that it appears to be contained in a cavity formed in the cerebral substance, from which it may be entirely removed, leaving the parietes clean. Small coagula of blood are sometimes found in the midst of the softened portion. The gray substance of the brain is the part most commonly affected with this species of softening, and particularly that of the convolutions. The forty-six cases reported by Lallemand, in his two first letters, (*Recherches anatomico-pathologique*), present sixteen examples of softening of the gray matter of the convolutions; thirteen of the gray matter of the corpora striata and thalami; four of the tuber annulare, eight of the medullary mater, and five in which both portions of the brain were nearly equally affected.

In a paper read before the Royal Academy of Medicine of Paris, in the year 1829, M. Tonnelé has pointed out the connexion which exists between many of the morbid conditions of the brain, discovered in those who die of apoplexy, and an inflammation of the sinuses of the dura mater. Thus, while the cavities of the latter, and of the superior cerebral veins, contained bloody concretions, and false membranes, sometimes mixed with pus, in every instance there was an injected state of the vessels of the pia mater; in many, infiltrations of blood beneath the arachnoid, extensive extravasation of blood upon the surface of the brain, with softening of the latter. In some cases, apoplectic cavities existed in the centre of the hemispheres; and in others, the gaping orifices of ruptured veins were very perceptible.

4. *Serous effusion.* Effusion of serum into the ventricles, and beneath the membranes of the brain, is frequently met with in apoplectic subjects; but, almost invariably, it is found to be connected with extensive congestion of the cerebral vessels; with inflammation, or other diseased

conditions of the membranes of the brain, or with extravasations of blood into the latter. In the majority of cases, therefore, the effusion of serum, found in the brain, after death from apoplexy, cannot be considered as a primary disease; nor is it probable that its accumulation can take place with such rapidity as to produce the symptoms of an apoplectic attack. The quantity of fluid effused often bears no proportion to the degree of the apoplectic symptoms. We find it in small quantity, even when the latter have been strongly marked and long continued; it exists in large quantity, when the symptoms have been slight; and finally, we see most extensive effusion in the brain, where there have been no symptoms of apoplexy whatever. The direct inference from these facts is, that in the cases of apoplexy with effusion, the presence of the fluid cannot be considered as the cause of the apoplectic attack. (Abercrombie.) There can be no doubt, however, that in certain cases, a state of coma, simulating apoplexy, does result from the general pressure to which the brain is subjected, from a very large accumulation of serum between its membranes, or within its ventricles. Effusion of serum in the brain is unquestionably a frequent consequence upon apoplexy, and is often the cause to which the sudden death of the patient is to be attributed. (Cruveilhier.) The number of apoplectics who die from effusion of serum within the cranium, equals, at least, according to the observations of Rochoux, the number of those who perish from the immediate effects of the cerebral hæmorrhage.

5. *A diseased condition of the membranes of the brain; or of the latter, with or without effusion of blood, or of serum.* In nearly all the cases of what Serres denominates meningeal apoplexy, (in other words, apoplexy without paralysis,) the membranes of the brain presented, on dissection, more or less of a diseased condition. When no effusion had taken place, this gentleman found the pia mater thickened and dry, the vessels somewhat distended, and the dura mater thickened in many places. The tunica arachnoides was opaque; and where it lines the ventricles, covered with whitish granulations, of an extraordinary form. In cases where serous effusion existed, the vessels of the meninges were found distended; the whole of the pia mater covered with a lace-work of innumerable small vessels; the arachnoid very opaque, thickened, and covered in certain places with a whitish exudation, particularly conspicuous along the principal venous trunks, over which it formed a kind of veil. The opacity and thickness of this tunic were much more considerable at the base of the encephalon, about the pineal gland, and in the ventricles, than elsewhere. The plexus choroides was almost invariably altered from its natural texture; being distended, and presenting transparent cysts, filled with a pellucid (sometimes yellowish) fluid, slightly saltish to the taste. At other times, this fluid was sanguineous or sero-sanguineous; more rarely, little clots of blood were found in the interior of the cysts. The size of the latter varies much. Serres has seen them as large as a small musket-ball. When sanguineous or sero-sanguineous effusions existed in the brain, besides the morbid condition of the pia mater described above, the arachnoid was evidently inflamed and red, without its vessels being very distinct. This appearance was peculiarly striking in the ventricles, which seemed to be the principal seat of irritation. (*Annuaire Med. Chirurg.* I.)

The substance of the brain in apoplectics is frequently found softened. The red softening of Lallemand, from infiltration of blood, we have already referred to. the white and purulent softenings of Cruveilhier are less frequently met with. In one case, reported by Morgagni, (*Epist.* V. 4.), a great quantity of pus was found in the left lateral ventricle, without any other lesion of the brain. Lapeuronie relates a curious case, occurring in a person with fracture of the skull, in which suppuration taking place within the cranium, the patient became completely comatose every time the pus was allowed to accumulate upon the surface of the brain. (Gama.) The symptoms, however, which are commonly produced by softening and suppuration of the brain, can scarcely be considered as identical with those of apoplexy.

Tumours, developed in the central parts of the brain, are occasionally observed after an apoplectic attack. We have ourselves met with a large tumour in the anterior part of one of the lobes of the cerebellum. Similar tumours are also noticed by various authors. Frequently the encephaloid tumour contains within its centre a large coagulum of blood, and is surrounded with small cavities containing blood, in the midst of a tissue very analagous to that of the brain. (Cruveilhier.)

A diseased condition of the blood-vessels is very commonly observed in the brains of subjects in whom death has resulted from apoplexy. There is sometimes ossification of the arteries, and in other cases that peculiar earthy brittleness

to which SCARPA has ascribed the production of aneurism. And the canal of the artery will be found, in many places, to be considerably contracted at the hardened parts; sometimes entirely obliterated. In other rare cases, numerous branches of the principal arteries of the brain will be found to present a succession of small opaque osseous rings, separated from each other by small portions of the artery, in its healthy state. This is a very common occurrence in the brains of elderly persons. In some cases, again, the inner coat of the artery is much thickened, of a soft pulpy consistence, and very easily separated; so that when a portion of the artery is compressed between the fingers, a considerable quantity of this pulpy matter is forced out. (ABERCROMBIE.)

The sinuses of the dura mater are often found diseased; their coats being thickened and indurated, and their canals obstructed or obliterated. When this is the case, the veins running into the sinuses are generally enlarged, tortuous, engorged, and apparently varicose.

After a single or frequent attacks of palsy, especially when the patient has survived for a considerable time, with persistent paralysis, and a decided feebleness of the intellectual faculties, after death, it is often found that an atrophy of the cerebral convolutions has taken place. The brain no longer fills the cavity of the cranium, but the vacancy is supplied by an effusion of serum into the sub-arachnoidean cellular tissue. Frequently the atrophy occurs in the whole of the hemisphere in which extravasation had taken place; more frequently, in the corpora striata and thalami optici. (CRUVEILHIER.)

Pathology. The peculiar character of the phenomena essential to apoplexy, a sudden suspension, namely, of the functions of sensation, consciousness, and voluntary motion, as well as of the intellectual faculties, indicates, very clearly, the dependence of the disease upon a morbid condition of some portion of the brain. On this point, nearly all medical authorities, even from the earliest periods of our science, are in accordance. In regard, however, to the exact nature of the lesions of the brain, by which the apoplectic symptoms are produced, a very great diversity of opinion has always existed. And even at the present day, notwithstanding the important discoveries that have been made, in regard to the structure and functions of the nervous system, and the very great industry with which its morbid anatomy has been investigated, the condition of the brain, in apoplexy, remains, as much as ever, a subject of dispute. While we admit the difficulties with which the inquiry is, to a certain extent, surrounded, we are nevertheless persuaded, that a careful examination of all the facts connected with the disease, will lead us very readily to correct views in regard to its pathology.

A suspension or abolition of the sensorial functions of the brain, is a phenomenon which occurs under very different circumstances. Sometimes, it takes place suddenly, in persons apparently in the most perfect health; while in other cases, it is preceded, for a longer or shorter period, by a deranged state of the functions of the brain, attributable to either acute or chronic inflammation of the organ. Hence, LALLEMAND, BOUILLAUD, DUCROT, CRUVEILHIER, and some other pathologists of equal eminence, have, for the sake of perspicuity, restricted the term apoplexy, to a sudden paralysis, general or partial, of the sensitive, locomotive, and intellectual functions. It cannot be too frequently repeated, remarks CRUVEILHIER, that the sudden occurrence of the symptoms is an essential character of apoplexy. The judge upon the bench, the orator in the tribune, the traveller in his carriage or on horseback, as well as the individual quietly seated at table, walking, conversing, or even wrapped in the most peaceful slumbers, and while, apparently, in the fullest enjoyment of health, is struck with the disease, as by a flash of lightning. Other pathologists again, extend the term apoplexy to all cases in which sense and motion become suspended or destroyed, either partially or entirely, provided this has not been preceded, for any great length of time, by very decided symptoms of cerebral disease. Taking, however, those cases to which the term apoplexy is most commonly applied, by a close attention to their symptoms it will be found that they differ from each other in certain important particulars: thus, in some instances, the patient is suddenly and completely deprived of sense and motion, from which state of deep stupor he cannot be roused by the application of the most powerful stimuli, but, in a very short time, expires. In other cases, he experiences a suspension, more or less sudden and complete, of sensation and of motion; in other words, falls suddenly into a state of coma resembling deep sleep; his features are not, however, distorted by any unnatural contraction of the muscles of the mouth; the respiratory action is equal on both sides of the thorax, and the limbs, on both sides of the body, are, to a certain extent,

excitable, when a proper stimulus is applied to them; or, if the stupor be not so complete, but that the patient may be roused from it momentarily, so as to understand words addressed to him in a loud tone of voice, he will present either hand or leg, on being asked so to do; thus indicating, that notwithstanding the torpor of the brain, the nervous and muscular power is equal on both sides of the body, and is benumbed, but not destroyed. If the patient recover from the attack, he regains, at once, the entire command of all his voluntary muscles, and, in general, the functions of the brain quickly resume the same state of vigour they possessed previously to the occurrence of the disease. In a third class of cases, besides the state of deep stupor observed in the last, there is also a complete destruction of sensation and of motion in certain of the voluntary muscles, generally those of one entire side of the body. No stimuli that can be applied, will excite in them the least feeling or contraction. The patient generally lies upon the side thus paralyzed, and the muscles of the face, especially those of the mouth, are drawn in the opposite direction. Although the profound stupor, in which the patient is, in general, at first plunged, may render the exact condition of the two sides of the body, somewhat equivocal, yet the distortion of the mouth is rarely, if ever, absent. Should the patient recover from the state of coma, the muscles on one side of the body will still remain paralyzed. The paralysis may, however, disappear in the course of time, but most commonly it is permanent.

In those cases, therefore, of apoplexy, not immediately fatal, we distinguish two very distinct forms of the disease; the one accompanied with simply a comatose condition of the brain; the other, with coma and a complete destruction of the influence of the brain over certain parts of the body: in other words, apoplexy without paralysis, and apoplexy with paralysis. Most usually the attack commences with coma, but in many instances, the paralysis is the phenomenon first observed; in some, it is unattended with stupor throughout. The consideration of these latter cases belongs properly to the subject of palsy.

Passing by, for the present, the consideration of the cases of apoplexy which terminate almost immediately in death; a very important inquiry presents itself in relation to the two forms of the disease marked by the absence or presence of paralysis; whether, namely, this difference in the phenomena by which the apoplectic attack is accompanied, can be traced to different morbid conditions of the encephalon. It is to Serres, that we are indebted for the satisfactory investigation of this question. Of one hundred cases of apoplexy which he studied with the utmost care, from the first onset of the attack until its termination in death, he found that twenty-one were unattended with paralysis, while seventy-nine presented a complete loss of motion of one or both sides of the body. On examining, by dissection, the contents of the cranium in the whole of these cases, he found invariably, that in those in which paralysis of the muscles was absent, the substance of the brain presented no trace of disease, while in the cases in which paralysis existed, certain portions of that organ were in a morbid condition—in other words, disorganized. From these and numerous similar facts, he was led to the following conclusions, namely; 1st. when the apoplectic attack presents no symptoms of paralysis, we may presume that the disease is seated in the meninges, and that the substance of the brain is neither dilacerated nor otherwise altered from its healthy condition: 2d. when, on the contrary, the apoplectic attack is attended by paralysis, it is the brain itself which is the principal seat of the disease.

Having, therefore, determined two important facts in relation to the pathology of apoplexy, first, that the sensorial functions of the brain may be suspended for a time, or completely destroyed, without any morbid change in the texture of the organ, and second, that persistent paralysis is very generally, perhaps always, produced by a disorganization, to a greater or less extent, of a part of the substance of the brain; let us now examine into the nature of those changes in the membranes and in the brain itself, by which the two phenomena, coma and paralysis, are produced. Recurring to the dissections of Serres, which are, in fact, the only ones from which any decided conclusions can be drawn, as in them alone the appearances detected after death have been accurately compared with the symptoms during life, we find, that of the twenty-one subjects who died of simple apoplexy —that is, unattended with palsy, in sixteen cases, where the disease had continued for a length of time, the pia mater was injected with blood, its vessels were much distended, and the tunica arachnoidea was opaque and thickened. In all, there was considerable effusion of serum, either into the ventricles, or upon the con-

volutions of the cerebrum. In one case, the arachnoid was red in the interior of the left ventricle, slightly opaque in the rest of its expansion, with numerous miliary granulations scattered over its surface. The left lateral ventricle was the seat of a sero-sanguineous effusion. In two cases, the arachnoid was sensibly inflamed, and a sero-sanguineous effusion existed upon the surface of the hemispheres. In the two remaining cases, there was no effusion of blood or serum, but the arachnoid had a dry and somewhat thickened appearance, with membraniform exudations. In some cases of simple apoplexy, SERRES has found the arteries upon the surface of the brain to be greatly distended, and one or more ruptured, giving rise to an extravasation of blood upon the convolutions,—in others, the extravasation was traceable to a rupture of the veins. A great number of cases of simple apoplexy, examined subsequently, have confirmed the general conclusions and facts stated above.

In regard to the condition of the brain in subjects who die of apoplexy with paralysis, of one hundred and seventy-one cases dissected by SERRES, with the utmost care, the texture of the brain, in every instance, was found to be more or less disorganized. Excavations of different sizes existed, generally in the substance of the cerebrum, but occasionally in the cerebellum or medulla oblongata. These excavations were filled with blood, varying in appearance, according to the time which had elapsed between its extravasation and the death of the patient,—while the portions of the brain immediately surrounding the effused blood, were red, softened, yellowish, hardened, and otherwise diseased, according to the length of time intervening between the attack and the extinction of life. These observations of SERRES, in relation to the disorganized state of portions of the brain, in cases of apoplexy with paralysis, are confirmed by the investigations of ROCHOUX, RIOBÉ, LALLEMAND, and CRUVEILHIER, as will be seen by referring back to our general account of the post-mortem appearances peculiar to apoplexy.

We find then, from the repeated and cautious dissections of SERRES and others, that in cases of apoplexy unattended with paralysis, if we except the serous and sanguineous effusions, the only morbid appearances detected after death are confined entirely to the meninges of the brain. The diseased condition of the membranes in these cases, SERRES refers, and we think with great propriety, to the effects of preceding irritation or inflammation; and as a constant correspondence existed between the alteration of structure in the two inner tunics of the brain and the effusion by which it was accompanied, this affords, he conceives, sufficient presumptive proof that they are connected together as cause and effect; and the effused fluids, whether blood, serum, or both, are pronounced by him to be of no consequence, whatever, in the production of the apoplectic symptoms.

That in a large number, perhaps in all of the active forms of apoplexy, the production of the disease is intimately dependent upon an irritation occurring in the brain, either primarily or transmitted to it from some other organ, is proved by so many and such striking facts, that we can have no hesitation in giving our full assent to the proposition. But we cannot admit, that irritation or inflammation simply of the membranes of the brain will explain the production of any of the symptoms which ordinarily characterize the apopletic attack. A suspension or interruption of the functions of the brain, occurring more or less suddenly, constitutes the very essence of the disease in all its forms. Now, that this suspension of its functions can occur without any change from the healthy condition of the brain itself, no one, we presume, will contend. Inflammation of the pia mater or arachnoid membrane, or, more strictly speaking perhaps, of the superficies of the brain, will unquestionably produce a state of coma; seldom, however, in its first stage, or until the period of excitement has terminated. But then the stupor is attended, and has been preceded by phenomena which will remove it from out the class of apoplexies strictly so called. In the numerous and diversified experiments of ROLANDO on the brains of living animals, we find that stupor and apoplexy were invariably produced, not, as SERRES has maintained, by an irritation merely of the membranes, but of the substance of the encephalon. Simple irritation, amounting to inflammation of the membranes, was attended neither by a suspension or interruption of sensation, nor of motion in any part of the animal's body. (*Saggio Sopra la verra struttura del Cervello.*) Irritation or inflammation of the meninges of the brain can, in fact, give rise to a complete attack of apoplexy in one of three ways only: either by the congestion which it produces in the superficial vessels of the cerebrum; by an effusion of serum, blood, or other fluid, into the

ventricles, or upon the convolutions; or by disorganizing to a certain extent the gray matter of the surface of the brain. The last, of course, did not occur in the cases examined by Serres, the substance of the brain being invariably found free from disease; but it has been observed by other pathologists. In all the examinations, however, of Serres, congestion of the vessels of the brain and its membranes evidently did exist; and with the exception of two cases, this congestion was accompanied with an extensive serous, sanguineous, or sero-sanguineous effusion, either upon the surface of the brain, or into the ventricles: and it is to the pressure exerted upon the brain by this congestion and effusion, in connexion with the irritated state of the organ, that we are inclined to refer the comatose symptoms of the disease. This leads to the important and much disputed question, will pressure upon the brain from congestion of its vessels or from effused fluids, produce a suspension of its sensorial functions? Abercrombie (*Diseases of the Brain and Spinal Cord*) denies explicitly that apoplexy ever depends upon pressure of any part of the encephalon, and the same assertion is repeated by Copland and Clutterbuck. All these gentlemen assume it as a fact that the brain is incompressible, and consequently they infer that it cannot suffer from pressure. Whether the texture of the brain be or be not compressible, it is not necessary for us at present to inquire: that it is liable to pressure, and that its functions will in that manner be impeded, can be clearly established. Nature, indeed, appears to have been extremely careful to guard the brain from the least degree of pressure, by inclosing it in the scull, and by the peculiar arrangement of the dura mater, and of the venous sinuses within the cranium; and from this very circumstance we should be led to infer that a very slight pressure would be injurious. Even Dr. Abercrombie admits that the brain may suffer from pressure, almost in the very sentence in which he denies it: thus, he refers the production of apoplexy to such a derangement of the circulation in the vessels of the head, that *more blood enters* by the arteries, *than can be transmitted* by the veins. Now, as the brain completely fills the cavity of the cranium, it is impossible for it to escape pressure, when a greater amount of blood enters into its arteries than can be removed by the veins. When slow serous effusion in the ventricles gradually distends these cavities to an immense size, and frequently reduces the hemispheres of the brain to a mere shell, of which there are so many instances on record, is it not evident that the absorption of the cerebral mass must have been produced by the pressure exercised upon it by the effused fluid? (Johnson.) In proof of the fact we have assumed, that, namely, a state of coma may be caused by pressure upon the brain and cease the moment that pressure is abated or withdrawn, numerous cases might be cited. We condense the following from the works of Abernethy, (II. 26.). A boy, fourteen years of age, fell from a height, upon his head. When brought to the hospital, he appeared to be almost in a dying state. The anterior inferior angle of the parietal and part of the frontal bones were found to be depressed. A piece of the cranium being removed by the trephine, a large quantity of coagulated blood was found beneath; another perforation was then made, and the surgeon, gently removing a portion of the cranium, introduced his finger into the aperture as far as the second joint, before he touched the dura mater. A third piece of bone being removed, four ounces of coagulated blood were taken away, upon which, the dura mater quickly rose to its proper level. The lad, who, at the beginning of the operation, lay quite insensible, with a feeble, intermittent pulse, and laborious, interrupted respiration, became restless, and expressed a sense of pain, towards its termination, and soon replied to various questions addressed to him. In a second case, a man, who was knocked down by a brick-bat thrown at him, was immediately brought to the hospital, in a state of profound apoplexy. The right side of the frontal bone, and lower part of the parietal, were beaten in. By three perforations of the skull, the depressed portion of bone was removed; a quantity of coagulated blood lay upon the orbitary processes of the frontal bone, and when a large handful was removed, it was found to have so pressed back the anterior lobe of the brain, that the surgeon could touch with his finger the transverse spinous process of the sphenoid bone. The brain, after the blood was removed, rose slowly, and the man began to show signs of returning sense. He was bled, and his bowels were emptied by a purge. The next day he was so far recovered as to give an imperfect account of the accident. Mr. Hill, of Dumfries, also relates a case, in which the artery of the dura mater was ruptured, without either fracture or depression of the skull. Four days after the

accident, two portions of bone were removed by the trephine, and so large a coagulum of blood was found lying upon the dura mater, as to make him fearful of removing all of it at once; but, on taking out a few ounces of it, the patient, who had heretofore lain in a state of apoplexy, looked up, on his being spoken to, like one awakened from sleep—knew and named every body, and raised the arm of the opposite side, which had been paralytic from the time of the accident. In the cases of apoplexy recorded by Drs. Bang and Watts, referred to in a former part of this article, the disease was evidently produced by pressure exerted upon the brain by blood effused between the skull and dura mater; and in the curious case reported by Lapeyroine, coma was induced every time a collection of pus was allowed to take place within the skull, and immediately ceased when the pus was removed. But we return to the question—will extensive engorgement of the vessels of the brain produce such a degree of pressure upon any part of the organ, as to occasion a suspension of its functions? Many cases of simple apoplexy occur, in which, after death, no other morbid alteration is presented by the brain excepting an over-distended state of its vessels. Two striking instances of this are related, the one by Morgagni, the other by Fouquier. In the first, the whole vascular system of the brain was distended with fluid blood, in a manner Morgagni had never before witnessed. Even some small vessels, which usually are scarcely perceptible, were extremely large and turgid. No other morbid appearance was discoverable. In the second, the exterior vessels of the brain, as well as those of the choroid plexus, were unusually turgid, and numerous points of blood were sprinkled over all the cut surfaces of the brain, the substance of which was very firm. The records of morbid anatomy are replete with similar facts; and we have ourselves met with them repeatedly, in dissections of apoplectic subjects. In such instances, Bricheteau, who appears to have examined the subject with the most attention, conceives that the destruction of the nervous influence and of life, must be referred to the general compression produced upon the brain by the universal turgescence of its vessels; and nearly the same remark is made by Portal and others. We fully accord with their conclusions. From a congested state of the cerebral vessels, remarks Gama,—who, it is proper to mention, refers all apoplexies to irritation of the brain,—an oppression of the nervous mass, a suspension, more or less prolonged, of the voluntary movements, and of the perceptions, may unquestionably result; but these phenomena are immediately dissipated when artificial evacuations of blood have been practised to a sufficient extent; the regular action of the vessels being thus restored, they quickly empty themselves of the blood by which they are distended. When, however, the state of engorgement continues too long, or is constantly augmented by the continued determination of blood to the brain, rupture of the vessels or serous extravasations may take place, which cannot be remedied with the same facility. The most fatal consequences, from extensive lesion of the brain, are then often experienced. The vessels of the meninges participate frequently in the engorgement of those of the brain; either from the commencement, or subsequently. It is probable that the membranes may themselves be the seat, in some cases, of irritation; but it is neither to this complication, nor to the distension of their vessels, that we should attribute the comatose condition of the patient; for, if the brain be not, at the same time, a centre of fluxion, it would support, without inconvenience, the mechanical effect of the tumefaction of its envelopes. In some cases, the cerebral congestion is directed towards the periphery of the organ; and we have then a case of simple apoplexy, with, probably, effusion. More generally, however, the congestion concentrates itself within its substance; and then a rupture or disorganization of the brain ordinarily takes place, and we have apoplexy, with paralysis. It cannot, however, be too frequently repeated, that the irritation of the brain is the actual cause by which the disease is produced, in all its forms. All sanguineous congestions are subjected to the same laws. Those which succeed to injuries of the head equally constitute real apoplexies: the only peculiarity by which they are marked, relates merely to the mechanical cause by which the irritation and congestion are produced. (*Plaies de tête.* p. 230.) It must be evident, that many of those apoplexies, unattended with paralysis, which occur suddenly, and are almost as promptly removed by an appropriate treatment, are produced by pressure upon the brain, from simple congestion of its vessels. In such cases, the quickness with which the functions of the brain are restored by a moderate loss of blood, precludes the supposition of any considerable morbid change having occurred in the

membranes or substance of the organ. The rapidity with which congestions are removed, in other parts of the body, is familiar to every physician; and, that the same prompt resolutions may take place in the congestions of the brain, can scarcely admit of a doubt. A boy, mentioned by Zitzilius, had drawn his neck-cloth remarkably tight, and was whipping his top, stooping and rising alternately; when, after a short time, he fell down apoplectic. The neck-cloth was now removed, and blood being drawn from the jugular vein, he speedily recovered. (Abercrombie.) Cases of a somewhat similar character are related by other writers, and one or two have fallen under our own observation.

It is to the oppression of the brain, resulting from congestive irritation of an intermittent character, that we must unquestionably refer those cases of apoplexy, the attacks of which assume a somewhat periodical character; occurring, and sometimes spontaneously disappearing, at tolerably regular intervals. Cases of this kind have been observed by Wepffer, Nyman, Torti, Portal, and others; but more especially, by Casimir Medicus. Now, it is impossible to suppose, that in such forms of the disease, any serious lesion of the brain can give rise to the successive attacks, and be promptly removed in the intervals. It is far more philosophical to refer their production to what we know does occur frequently in other organs; a periodical irritation, namely, with congestion. But, if simple congestion gives rise to the more favourable forms of apoplexy, it appears capable, also, of producing the most violent and instantaneously fatal ones. Dissection fully establishes this fact. If a sudden and great distension of the vessels of the brain takes place, and the vessels are not speedily unloaded, either by artificial means, or by the rupture of their coats, or an exhalation of blood or of serum, it is very evident that, the whole substance of the brain becoming oppressed, the functions of life must consequently be destroyed. And after death, the only morbid appearance presented by the encephalon, will be, in such cases, an overloaded condition of its blood-vessels. It is probable, also, that to the same cause, oppression, namely, of the sensorium, from extensive congestion of its sanguineous system, are to be attributed those rare cases of apoplexy, in which death has promptly followed the attack; and, upon dissection, no morbid appearance whatever, it is stated, could be detected in the brain or its membranes; the turgescence of the vessels having disappeared at, or immmediately after death, as we find it to do in other organs. (Bricheteau.)

Two circumstances would appear to be necessary, in order that pressure of the brain shall produce torpor of its functions: the first is, that it occur suddenly; and the second, that its effects be experienced by, at least, a considerable portion of the surface of the organ. The brain has the power of adapting itself to a very considerable amount of pressure, when not suddenly subjected to it. Accumulations of serum, and of blood, have slowly taken place in the brain, to a very great extent, and its functions have gone on, for a long time, without, apparently, being the least affected. Even when the pressure has been at first such as to occasion some degree of stupor, this has, in many instances, disappeared spontaneously, without any diminution in the degree of pressure. Pressure upon particular parts of the organ, will also be borne with comparatively little inconvenience. When, however, the whole or a large portion of the superior surface of the brain is, from any cause, suddenly subjected to it, a state of coma is almost invariably the result. This is proved by the case (by no means unique) of the beggar, referred to by many physiologists, whose brain was exposed by a perforation in the skull, and in whom a state of drowsiness was induced when the brain was pressed upon, increasing with the degree of pressure, until at length the man would become comatose.

In some cases of apoplexy, the congestion of the brain is so considerable, as to produce a rupture of one or more vessels within the cranium; or the distended vessels are relieved by a spontaneous hæmorrhage, and the blood is poured out into the ventricles, or over the surface of the cerebrum. If by this means the congestion is removed, and the extravasated blood is small in quantity, the patient will recover from the stupor into which he had been previously plunged, and in a short time will recover entirely his ordinary state of health. But, if the effused blood be in considerable amount, the coma will ordinarily become more intense; and death, almost immediate, may be the result. If, remarks Serres, referring to his own repeated dissections, the irritation of the membranes of the brain had been intense, sudden, and of short duration; if the membranes were inflamed, partially or universally, the fluid effused within the ventricles, between the convolutions, or in the commencement of the spinal canal, was

sanguineous or sero-sanguineous. This latter was so connected with the irritated or inflamed condition of the membranes, that if the irritation or inflammation existed in one or both ventricles, the effusion of blood was confined to that part. If, on the contrary, which more rarely occurred, it existed only on the exterior of the encephalon, the blood was found solely on the surface of the brain: the ventricles were empty, or the liquid which they contained was simply serum. This shows the intimate connexion between the effusion, in these cases, and the part of the encephalon which appeared to be the principal seat of the congestion. Cruveilhier has remarked, very correctly, that the phenomena of compression, those, namely, connected with cases of stupor without paralysis, are the only ones observable in those apoplexies in which the hæmorrhage takes place in the ventricles, or upon the surface of the brain, without rupture or disorganization of the latter; because, in these cases, the effused blood occupies a large surface, and compresses, pretty uniformly, the whole mass of the brain—an opinion which appears to be supported by facts, and by the observations, generally speaking, of other pathologists.

Serous effusion, alone, is but seldom, perhaps, a cause of the apoplectic attack. It is doubtful whether the pressure produced by an accumulation of serum, can ever take place with sufficient suddenness to cause an immediate suspension of the functions of the brain. Extensive serous effusion into the ventricles, or beneath the membranes of the brain, will undoubtedly produce a state of coma, more or less complete; but, in such cases, the torpor of the brain comes on slowly and gradually, without any thing like a sudden stroke or fit, and may be owing as much to the disorganization of the brain as to mere pressure. In nearly all the cases of apoplexy in which, after death, serum is found in the brain, other morbid appearances are present, fully sufficient of themselves to account for the production of the disease. A state of congestion, in particular, so often present, and upon which the apoplectic attack so frequently depends, has been shown, by recent investigations, almost invariably to give rise to a serous effusion, often to a very considerable extent.

The distinction of apoplexies, by the older writers, into serous and sanguineous, is altogether unfounded. Independently of the serous effusion, when it does occur, being almost invariably accompanied, as we have just remarked, by an engorged condition of the arteries or veins, and other morbid states of the brain, or of its membranes,—many of the cases which terminate by a serous effusion, exhibit in their early stages all the phenomena usually assigned to sanguineous apoplexy, such as flushed countenance, strong pulse, vigour of constitution, &c., whilst, on the other hand, many of those accompanied by paleness of countenance and feebleness of pulse, and occurring in debilitated or broken-down constitutions, or in the aged, commonly referred to the class of serous apoplexies, will be found, on dissection, to be purely sanguineous. Portal describes a series of cases strikingly illustrative of these facts.

From the foregoing remarks, it will be perceived that to oppression of the brain, from engorgement of the cerebral vessels, especially those of the meninges and superficies of the organ, with or without effusion between the membranes or into the ventricles, we are inclined to attribute in the greater number of instances, the production of those cases of apoplexy which are unattended with paralysis; and we shall hereafter find that the comatose symptoms of nearly all attacks of the disease are referable to a similar cause. The coma may, however, in some instances, be dependent upon a disorganization of the cortical substance of the convolutions of the brain. Bouillaud has presented some cases of this kind, but they are attended, always, with peculiar phenomena which prevents their being strictly considered as apoplexy.

To what cause are we to attribute the extensive engorgement of the cerebral vessels in certain apoplectic attacks? The common explanation, if explanation it can be called, of an increased determination of blood to the head, is inadmissible. By the action of the heart alone, a greater amount of blood cannot possibly be determined to one part of the body than to another. We are not quite so positive, however, that apoplexy may not be sometimes produced by the heart driving the blood with such force into the vessels of the brain, as to occasion a rupture of one or more of them, especially when the brain or its vessels are already in a diseased state. This is probably the mode in which apoplexy is often produced in subjects labouring under hypertrophy of the heart, and in such cases as the one reported by Cruveilhier, in which a contraction of the aorta existed just beyond the origin of the carotids, in consequence of which the column of blood in the latter was driven

with greater force into the vessels of the head than under ordinary circumstances. The blood-vessels of the brain, from the relative delicacy of their coats and the absence of that support which the vessels of other parts of the body derive from the surrounding cellular membrane, are always peculiarly liable to rupture, and this liability is increased in many instances by a morbid state of their parietes.

In the great majority of cases, it is to a suddenly excited and intense irritation of the brain or of its membranes, that the production of the congestion giving rise to apoplexy, is unquestionably to be referred. Every organ, when the seat of irritation, becomes, as is well known, a centre of fluxion, and an increased amount of blood is determined to its vessels. If the irritation be suddenly carried to its highest degree, the congestion produced is often so great, as to occasion almost immediately the death or disorganization of the part in which it is seated. That apoplexy may very generally be traced to encephalic irritation, can scarcely be doubted when we recollect that nearly all its remote and exciting causes are precisely those which ordinarily give rise to inflammation of the brain; and, more especially when we observe the attack so often to be produced almost immediately upon the transfer of irritation from the stomach, the skin, or other remote organs, to the brain; and when, in addition to these facts, we consider the morbid appearances brought to light by dissection. The symptoms by which the apoplectic seizure is so often preceded, indicate a state of more or less cerebral irritation and an increased determination of blood to the vessels of the head. All the symptoms of apoplexy are also the ordinary results of well-marked inflammation of the brain, whenever the disease is not cut short by appropriate remedies, or the death of the patient does not occur during the first periods of the disease or the stage of excitement. The only difference which exists between ordinary apoplexy and that which succeeds to acute encephalic inflammation, is the suddenness of the attack in the one case, and its gradual approach, subsequent to the acute inflammatory symptoms, in the other. To these facts may be added the very common occurrence of cerebral inflammation as a sequel to the apoplectic attack when this has been but imperfectly recovered from, or the patient at too early a period returns to a stimulating diet and his ordinary avocations. So striking is indeed the relation between apoplexy and inflammation of the brain, that we are only surprised it should have been so long overlooked by the majority of medical writers; more especially as Stoll had already very ably run the parallel between the two diseases.

We maintain, then, that in all cases of apoplexy marked simply by coma, and unpreceded by symptoms of decided cerebral inflammation, there takes place a sudden over-distension of the blood-vessels of the brain, the result of preceding irritation of that organ. Abercrombie, however, has attempted to show that no more blood can enter into the vessels of the brain at one time than at another; in other words, that the cerebral vessels always contain the same absolute amount of blood. But the records of morbid anatomy prove most conclusively that the vessels of the brain, both arteries and veins, are often engorged to a very great extent with blood, and that not unfrequently, in addition to this engorgement, sanguineous extravasation has likewise taken place. The arguments of Dr. Abercrombie in support of his position would be conclusive, we admit, were we to suppose the mass of the brain to be perfectly incompressible—which, however, is not the fact. Fully authenticated cases are recorded, especially by the surgical writers, in which the surface of the brain has been found so much depressed by blood extravasated beneath the skull, as to leave a permanent depression, capable of containing several ounces of blood; in other instances, the depression has been obliterated the moment the coagulum of effused blood was removed. Now, we care not how this is explained, whether by the squeezing out of the fluids from the part, or the closer approximation of the molecules of which the substance of the brain is composed—we merely adduce the facts to prove that the mass of the organ is compressible. Indeed, were the mass of the brain absolutely incompressible, extravasation of blood within the cranium could never take place, as the unyielding nature of the brain would be an effectual barrier to the escape of a single drop from even a ruptured vessel of considerable size. We should even be inclined to adopt the opinion of Cruveilhier, that the brain, namely, is eminently compressible. (*Dict. de Méd. et de Chirur. Prat.* III. 225.) But be this as it may, we know that the brain, in common with the other organs of the body, may be the seat of irritation, and that irritation when of a certain grade will produce a congested state of the vessels of the organ in which it occurs.

That in many cases of apoplexy, an increased amount of blood is determined to the vessels of the head, is proved by the flushing of the face, the turgidity of the features, the increased size and throbbing of the exterior vessels of the face and neck, which precede and accompany the attack. Numerous writers have likewise remarked the unusual quantity of blood which is discharged from the integuments of the head, in the dissection of subjects that have died during the apoplectic fit; in some of Cheyne's dissections, upwards of a pound was discharged in this manner. When in addition to these facts we find that in the great majority of cases the brain after death from apoplexy does present either extensive engorgement or at least a highly injected state of its vessels, with often an extravasation of blood from rupture or exhalation; taking the whole in connexion, we have certainly very solid proof of unnatural distension of the vessels within the head, and consequent pressure upon the brain.

Dr. Stokes, in his lectures on apoplexy, confirms the accuracy of the foregoing views. Presenting to his class a specimen of apoplectic effusion, "See," he remarks, "how extensively the substance of the brain has been torn,—the cavity formed in this way is, you will perceive, filled up with a large clot. Now there is one consideration which strikes us at once, in looking at an effusion of this kind into the substance of the brain, whatever may be its situation or extent, and this is, *that the brain must be a very compressible organ.* Here we see the brain torn, a cavity of large size formed, and this completely filled with blood. Now it is obvious that the rest of the brain must give way, in order to give room for the formation of this cavity. If, then, it be true, that the brain is compressible, so far as to admit of the formation of a large cavity, it necessarily follows that, contrary to the opinion of Drs. Abercrombie and Clutterbuck, the quantity of blood in the brain may vary, and be at one time greater than at another. It may be argued against this, that the illustrative proof in this case is derived from a pathological condition, and that under such circumstances, the brain has room for the formation of a cavity, by the emptying of some of its vessels. Here, it is urged, is a cavity, but the emptying of the vessels of the brain compensates for it; thus room is found, and there is no increase in the quantity of blood circulating in the brain. This, however, I look upon as a mere *petitio principii*, nor have we any reason to think, that, in a case of apoplectic effusion, there is any corresponding emptying of the vessels, for dissection almost always shows *a surcharged state of all* the vessels." (*Lond. Med. and Surg. Journ.* Sept. 1834.)

All tissues, the vessels of which are in a state of congestive irritation, are liable to be the seat of a spontaneous hemorrhage more or less extensive; and that such is precisely the case with the tissues of the brain in apoplexy, is, we conceive, fully established by a careful examination of the causes and symptoms of the disease, and a comparison of these with the morbid appearances so frequently revealed by dissection. With Gama, therefore, we embrace entirely the opinion of those physicians who consider apoplexy to be merely a grade of encephalitis. The slow or rapid invasion of the cerebral irritation, its termination in a hemorrhagic action of the vessels of the affected tissue, or its regular march through the different periods of inflammation to a complete disorganization of a portion of the organ, constitutes all the difference which exists between the phenomena of apoplexy, paralysis, or encephalitis and its various sequelæ. These facts have been very happily illustrated by Lallemand, Serres, Gama, and other later pathologists. We are not, however, prepared, let it be understood, to deny that mechanical impediments to the return of the blood from the head, may cause, under certain circumstances, an attack of apoplexy, such as ligatures about the neck, tumours pressing upon the jugulars, disease of the lungs, heart, and large blood-vessels, &c.; but even in such cases, we maintain that congestion of the cerebral vessels and consequent oppression of the brain do take place, and that in this manner the phenomena of the disease are produced.

In many cases of apoplexy, the first impression of the exciting cause would appear to give rise to a decided sedation of the brain and entire nervous system; reaction, however, taking place, congestion and extravasation result. The appearance of the patient is, at first, somewhat similar to that of an individual in a state of syncope. His countenance is pallid, his eyes fixed and dim, respiration is slow and scarcely audible, the pulse small, slow, and feeble; the limbs are perfectly relaxed, and the surface of the body often considerably below the natural temperature. These symptoms soon give place, however, to those which ordinarily ac-

company the apoplectic attack. It is probable that in some instances the sedation of the brain may be carried to such an extent as to produce immediate death, without giving time for reaction to occur; in this case, the brain will present upon dissection no traces of disease. A strong analogy exists between the apoplectic cases here referred to, and the injury of the brain resulting from concussion. Thus, the immediate effects of the injury may be such as to produce instantaneous death; but should this not be the case, the brain either resumes gradually its functions, and the patient suffers no subsequent inconvenience, or an irritation and congestion of the cerebral vessels take place, and the patient is rendered completely apoplectic. In such cases, the extravasation generally occurs within the same portions of the substance of the brain as in ordinary apoplexy with paralysis.

The cases of apoplexy commencing as we presume with decided sedation of the sensorial and nervous functions, are most commonly those produced by some sudden and violent mental emotion. Thus persons have been struck almost instantaneously dead by a sudden paroxysm of extreme grief, fear, surprise, horror, joy, anger, shame, &c., and after death the brain has presented no traces of disease; but if reaction come on before the patient expires, we have then all the symptoms of an apoplectic attack; and either congestion or extravasation within the skull, with or without disorganization of the brain, is the post-mortem appearance observed. We have had an opportunity of dissecting cases of this character, in which death occurred during the period of what we presume to be nervous sedation, and also, subsequently to the occurrence of reaction; no morbid appearance of the brain in the one case could be detected, in the other the state of that organ was the same as is most usual after death from apoplexy.

In the simple form of apoplexy, or that unattended with paralysis, the congestion of the brain is either resolved, and the patient promptly recovers the entire use of all his faculties, or, in consequence of a large effusion of blood within the ventricles or upon the surface of the brain, the recovery is more slowly effected, or the torpor of the brain which is induced is so great as to cause a speedy extinction of life.

That the coma in apoplexy is invariably the result of the oppression experienced by the brain, either from congestion of its vessels or from extensive extravasation of blood upon the convolutions or into its ventricles, is proved, we conceive, by the fact, that in cases of paralysis without stupor, the effusion of blood is generally small in quantity and confined entirely to an excavation within the substance of the brain; but when a paralytic becomes suddenly affected with all the symptoms of a complete attack of apoplexy, and dies, it will then be found, pretty generally, either that the vessels about the surface of the brain are morbidly injected with blood, or that the blood extravasated in the first instance within the substance of the organ, has burst through the surrounding portion of medullary matter, into the ventricles or upon the surface of the convolutions. There are, however, cases in which effusion of blood upon the surface of the brain will give rise to paralysis and not to stupor; in such instances, the extravasated blood is in considerable quantity and confined to a small space, thus producing only partial pressure upon the cerebral mass. When, however, the extravasation is very extensive, both coma and paralysis may occur simultaneously without the substance of the brain itself being injured. Thus, in extravasations of blood beneath the skull, from external violence, paralysis of the opposite side to that on which the blood is effused, often occurs, with or without coma; but this would appear to demand a much more extensive extravasation than can be supposed ordinarily to occur in apoplexies strictly speaking. The fact, however, is demonstrated by the following experiment performed by Cruveilhier: by means of a trephine, a portion of the skull of an animal being removed, a number of thin laminæ of horn were inserted between the bone and dura mater; paralysis was produced whenever the compression in this manner was carried to a certain extent. It may be objected to this, that Serres, in several instances, laid bare, by perforating the skull, the longitudinal sinus, and piercing the latter, immediately closed with accuracy the opening in the bone; and although the dura mater became covered with a thin layer of blood, no symptoms of either stupor or paralysis were produced. Cruveilhier repeated this experiment, and with the same result; but he found that the cavity of the skull is so completely filled by the brain as to allow but a very small amount of blood to escape from the sinus; hence he concludes that this experiment is inconclusive—and he has shown that

the inference based upon it is disproved by other facts and experiments. (*Dict. de Méd. et de Chirur. Prat.* III. 225.)

According to the facts collected from the numerous clinical observations of SERRES, it appears that the simple form of apoplexy to which our remarks have heretofore been principally directed, generally occurs before the fifteenth and after the sixtieth year, and more frequently in females than in males. Its invasion is almost always slow, and preceded by various premonitory symptoms, of which the most constant are, a general torpor of the system, a disinclination to mental exertion, fatigue from the slightest exercise of the intellect, obtuse perceptions, great inclination to sleep, slowness of respiration and of the circulation, diminished heat of the surface, deficient secretion, derangement of the digestive functions, and occasionally, nausea and vomiting. In many of the cases observed by SERRES, the disease stole on so imperceptibly, that it was thought the patients were in a deep sleep, when in reality they were completely apoplectic. When, however, the attack succeeds to the suppression of some habitual drain from the system, or of cutaneous eruptions, or is brought on by a blow or fall on the head, the invasion is more sudden, and the attack is generally preceded by a violent pain of the head.

During the apoplectic state, the character of the pulse varies, according to the age and strength of the patient, but invariably, the balance between the function of respiration and that of circulation is destroyed; the frequency of the pulse being contrasted with the slowness of the respiratory movements. In proportion as this contrast is widened, the state of stupor and of coma is evinced, and its degree is exactly proportioned to the difference which exists between the two functions. The suspension of the senses generally occurs in the following order: first, that of touch; second, that of sight; third, that of hearing; then embarrassment of the tongue, and loss of speech; then somnolency, and coma, accompanied with slowness of respiration and activity of circulation. In proportion as the two latter functions recover their equilibrium, the coma diminishes, the hearing is restored, then the sight; and finally, the inability to speak, and the difficulty of using the tongue, disappear.

In the form of apoplexy which is accompanied with paralysis we have ordinarily, in the first instance, the same condition of the brain precisely as in the simple form of the disease. In the greater number of cases, the patient is first seized with torpor, more or less complete, of the sensorial powers, to which succeeds, after a longer or shorter interval, paralysis of one side of the body; the first period of the attack indicating a state of irritation and general congestion of the brain, the occurrence of paralysis being invariably connected with disorganization of a portion of the brain, produced for the most part by an effusion of blood from the vessels seated within its substance. If the effused blood be small in quantity, and confined strictly to the apoplectic cavity that has been formed in the midst of the cerebral mass, and at the same time the congestion of the brain is abated or removed, the patient recovers from the state of coma, but the paralysis persists. If the disorganization of the brain has occurred on one side only, the loss of motion and of sensation is confined to one side of the body, and, in almost every instance, on the side opposite to that on which the extravasation takes place. If both hemispheres of the brain are the seats of extravasation, there results a paralysis of both sides of the body. When the amount of blood extravasated is considerable, the symptoms of coma disappear very slowly; hence, as remarked by CRUVEILHIER, the persistence of stupor is always a bad symptom, indicating either a very extensive effusion within the substance of the brain, or the communication of the apoplectic cavity with the ventricles or surface of the organ, or with both. The effusion of blood, and consequent injury to the brain, may be so great as to cause almost immediate death.

In all the apoplectic cases in which death took place at the end of a few hours, CRUVEILHIER found that the blood had burst into the ventricles or between the convolutions. Sometimes the paralysis which ensues is universal; the mouth is not drawn to either side, and the patient dies as from asphyxia, or as animals in whom both the pneumo-gastric nerves have been divided. Dissection, in such cases, shows that the extravasation has taken place in the substance of the tuber annulare, or has burst from thence along the base of the skull. All the facts which have been collected, show, that it is to the disorganization of the brain, the persistent paralysis is invariably owing; and hence it may occur equally whether the brain be disorganized from effusion of blood, from acute or chronic inflammation, or from any other cause.

The paralytic symptoms, in cases of

apoplexy, may disappear gradually as the blood is absorbed, and the ruptured surfaces of the brain become reunited by a kind of cicatrization. The possibility of the perfect and entire disappearance of the palsy, has been proved by Riobé, Brichetèau, and others; but in general it is permanent, or, at least, the patient experiences, during the remainder of his life, a debility, more or less considerable, of the functions of sensation, of voluntary motion, and of the intellect.

In many instances, after a prompt recovery from a first attack of apoplexy, the disease recurs sooner or later. If the case has been merely one of the comatose form of the disease, and the patient neglects subsequently those precautions which his situation so imperiously demands, in a very few hours he may be seized with a fit of a more serious or fatal character. The act of vomiting, violent sneezing, a sudden change of position, or a slight shock or excitement of the mind, is often the exciting cause of the second attack. More commonly, however, the latter does not occur until after an interval of a week, or longer. When it takes place about the eighth or ninth day, it may be attributed, pretty generally, to either a renewal of the congestion and effusion of blood, occasioned by the parts surrounding the original apoplectic cavity becoming inflamed, or to an extensive softening of the cerebral mass.

Apoplexy, with lesion of the substance of the brain, most commonly attacks suddenly, particularly in corpulent persons, of plethoric habits and short necks, and who lead luxurious, intemperate or debauched lives. A few moments before the invasion of the disease, the brain exhibits, occasionally, an extraordinary excitement, accompanied by an unusual vigour of intellect, and an energy of expression which the individual had never before exhibited. Sometimes, a numbness of one side of the body, or of the face, or a fixed pain in the head, precedes the attack; more frequently, an embarrassed state of the tongue, or a difficulty of pronouncing certain words or letters. These symptoms may, however, disappear, especially if a spontaneous hæmorrhage occur from the nose, or from hemorrhoides, or if bleeding or active purging be resorted to, without the apoplectic seizure resulting. Whether preceded or not by premonitory symptoms, the face, at the instant of attack, assumes an unusual hue, the cervical and facial veins swell, the tongue falters, the sight is obscured, the hearing blunted, and the individual is finally deprived of sensation and of consciousness, and falls down in a state of coma, upon that side which is subsequently to become paralytic. In a few hours after the attack, provided the brain has not already suffered laceration from effusion of blood, the respiration becomes considerably slower than natural. The venous blood, in consequence, experiences a mechanical obstruction in its return to the heart; and the latter organ begins, in proportion, to react: the pulse, accordingly, becomes hard and frequent; the artery, as it were, vibrates under the finger. The force and hardness of the pulse continue until extravasation takes place in the substance of the brain, when it becomes small, quick, and concentrated. During the first period of the attack, respiration is equal on both sides of the body: it continues so, sometimes, even for days. But ultimately the thorax becomes unequally dilated; one side of the chest is, as it were, struck motionless, while the other seems to redouble its activity; the chest also appears flatter on the inactive side than on the other. This symptom so generally precedes the paralysis, that the latter may usually be predicted when the first appears; and Serres believes it may even be prevented, by proper remedies resorted to at this period. The sensibility is sometimes equally obtuse, on both sides of the body, before paralysis has taken place; but often more strikingly so, on the side which is to become paralytic. Hemiplegia finally occurs. Serres, who has passed whole days and nights at the bed-side of apoplectic patients, watching the various phenomena presented during the progress of the attack, has seen distortion of the mouth, preceded several hours by certain convulsive movements of the side subsequently deprived of nervous power. Sometimes the hemiplegia was preceded by an almost tetanic rigidity of the whole side. Occasionally, paralysis appeared first in the muscles of the mouth; at other times, in those of the extremities; the lower limbs being always paralyzed before the superior. Sensibility will sometimes continue in the affected limb; but, more commonly, loss of sensation precedes and accompanies the loss of motion. (*Annuaire Méd. Chirur.* I.)

Treatment. In few diseases have the curative means, proposed by different writers, been influenced, to a greater extent, by hypothetical views entertained in relation to their pathology, than in apoplexy. In consequence of this, the most dissimilar and even opposite modes of treatment, have been, by turns, recommended and

denounced. According to one authority, the cure of the disease is to be trusted solely to profuse and repeated bleedings; while, according to another, a moderate bleeding is proper only at the very onset of the attack, and when it is one of sanguineous apoplexy; but subsequently, or in the serous form of the disease, the loss of blood, in any quantity, is not only useless, but decidedly injurious. A third class of practitioners trust solely to the use of purgatives or emetics; a fourth object to both, but urge the necessity of resorting at once to stimulants and tonics; while another, of equal eminence, adopting the maxim of Hippocrates, that it is impossible to cure a strong apoplexy, and very difficult to cure a feeble one, discard the use of all active remedies, and leave the patient entirely "to the efforts of nature." Notwithstanding experience as well as theory is invoked in favour of all these plans of treatment, yet when we come to test them carefully by their general results, the real value to be attached to each will be very readily determined; and we shall find, that the weight of testimony derived from this source, is greatly in favour of those remedies which the phenomena ordinarily attendant upon the disease, as well as the best established views, in regard to its pathology, would have pointed out à priori.

It is unquestionably true, that in many cases of apoplexy, the injury which the brain has suffered is such, that death must inevitably ensue, whatever may be the treatment pursued, or however promptly or energetically it may be carried into effect; whilst, in other instances, a perfect recovery will take place when the remedies have been, apparently, the most inefficient. In a few cases, the apoplectic symptoms have been even known to disappear spontaneously; and that in a very short period. Nevertheless, the disease is one in which a judicious plan of treatment, early instituted, will, in the greater number of cases, be productive of decided benefit; either restoring at once the functions of the brain, or, at least, arresting the fatal termination of the attack, and preserving the patient from a state of decrepitude for the remainder of his days.

The remedies which experience has shown to be the most efficacious in the treatment of apoplexy, are bleeding, general and topical, cold applications to the scalp, counter-irritants to the extremities and surface of the body, purgatives, blisters, and such other means as are calculated to abate or remove cerebral irritation and congestion. Previously to entering upon the consideration of those remedies, it will be proper to point out certain measures necessary to be carried into effect immediately upon the occurrence of the disease, and before even the more active remedies are commenced with.

The first thing to be attended to by the physician, when called to a patient labouring under an attack of apoplexy, is to loosen or remove all such portions of his clothing as may be supposed capable of compressing any part of his body, more especially the neck, chest, and abdomen; the patient, at the same time, being placed in such a position as will have the least tendency to prevent the free return of blood from the vessels of the head, and removed, with the least possible agitation, to a large, cool, and well-ventilated chamber, and placed upon a mattress, with his head and shoulders very considerably elevated. This latter direction, Serres, with great propriety, insists upon, as a matter of no trifling importance, having himself seen the most fatal results from its neglect. He even recommends the patient, when it is practicable, to be supported in a sitting posture. In addition to these measures, it is strongly recommended, by many eminent practitioners, to cover the head, previously shaved, with cloths wet with cold or iced water, and at the same time to immerse the feet in hot water, or to apply frictions, with some stimulating liniment, over the whole of the lower extremities; and the recommendation, we are convinced, is a very judicious one, in nearly every case. The remedies which are next to be resorted to, as well as one or two that have been proposed, but, in our opinion, either of doubtful propriety, or absolutely injurious, will now be considered.

1. *Bleeding*. The subtraction of blood is unquestionably one of the most efficacious means we possess for the cure of apoplexy. Employed at a sufficiently early period after the attack, it will frequently very promptly remove the congestion of the cerebral vessels, often prevent extensive extravasation of blood, and preserve the substance of the brain from rupture and disorganization. Even at a later period, it will, in many cases, greatly ameliorate the symptoms, prevent the extension of the injury which the brain may have already received, promote the absorption of the effused fluids, and the contraction and cicatrization of the apoplectic cavity. Bleeding, it is true, has been objected to, in the treatment of apoplexy, by a few respectable writers; and its use, by others, is restricted to certain forms of the disease.

The objections, however, that have been made to the general employment of blood-letting, in the early period of the attack, and its cautious repetition, at a more advanced stage, will be found, we apprehend, to be purely hypothetical, and based upon erroneous views of the character of the disease, or to hold good solely against the abuse of the remedy. To say nothing of the concurrent evidence borne in favour of the good effects of blood-letting, by the great majority of those medical writers whose opinions, on practical subjects, are the most deserving of respect, the very symptoms by which the disease is ordinarily accompanied, the morbid state of the brain, revealed by dissection, and the fact, that spontaneous and copious hæmorrhage from the nose, lungs, or hæmorrhoidal vessels, have either prevented the occurrence of the attack, when the most unequivocal symptoms of its approach have been present, or completely removed the disease when it has occurred,—all press upon the attention of the reflecting practitioner the importance and necessity of blood-letting in the treatment of apoplexy. And we are persuaded, judging from our own experience, that more advantage is to be expected, in the generality of cases, from its use, than from almost any other remedy. Whenever, therefore, the attack is recent, and occurs in a plethoric habit, accompanied with a full, active pulse, and more especially, when we have evident symptoms of an undue determination of blood to the vessels of the head, no time should be lost in resorting to the abstraction of blood, and carrying it to such an extent as may be demanded by the emergency of the case. Even when the indications for general blood-letting are not so strongly marked as in the cases just referred to, or after the free use of the lancet, the topical abstraction of blood, by means especially of cups to the head, will almost invariably be called for. Indeed, we can conceive of few cases of genuine apoplexy, in which the remedy employed, in one or other of these ways, can with propriety be dispensed with.

Some difference of opinion has existed among physicians as to the part of the body from which the blood should be drawn; some preferring the opening of the jugular veins, others recommending the division of the temporal arteries, and others, again, with Aretæus and Morgagni, insisting upon the superior efficacy of bleeding from the occipital veins; while many of the continental physicians prefer bleeding from the feet, these being first immersed in hot water; this is especially recommended when the apoplectic attack has immediately succeeded to a suppression of some habitual evacuation, or has been caused by metastasis of rheumatism or gout. We confess, however, that in practice we have seen no particular advantage which the detraction of blood from any other part of the body has, over bleeding in the usual manner from the arm. We are fully aware, that in cases of local congestion, as a general rule, the nearer we take the blood from the part in which the disease is seated, the better; yet, as the great object of the bleeding, in the first period of the disease, is to diminish promptly the mass of the blood in the vessels, and reduce, at once, the action of the heart, a large bleeding from the arm, will be equally effectual, if not preferable, to either dividing the temporal arteries or opening the jugular veins; subsequently, however, a judicious resort to topical blood-letting will be all-important. The dispute which at one period existed among physicians as to the propriety of drawing blood from the sound or the paralyzed side, must now be considered altogether puerile: it is of little moment which side is made choice of, provided the bleeding be resorted to with sufficient promptitude and carried to a proper extent.

In general, the loss of a considerable quantity of blood will be demanded at the first bleeding; nevertheless, the only rule that can be laid down by which to measure the extent of the evacuation, is the effect produced by it upon the symptoms of the case. Cheyne directs two pounds to be drawn off at first, and he has known from six to eight pounds taken from a person by no means robust, before the disease, which ended favourably, began to yield. The bleeding should undoubtedly be carried to such an extent as to produce a marked reduction in the action of the heart; and to effect this as quickly as possible, the blood should be drawn from a large orifice. Gregory even advises that two veins be opened at the same time; and we believe that general experience will confirm the remark of Cruveilhier, that one large bleeding, at the very commencement of the disease, will produce a much more beneficial effect than the repeated abstraction of small quantities of blood at short intervals.

In thus recommending the prompt and free abstraction of blood, in the early period of the apoplectic attack, we would not wish, however, to be understood as directing it to the same extent, indiscriminately, in all

cases. We agree entirely with the observation of Abercrombie, that in the extent of our evacuations, a due regard is always to be had to the age and constitution of the patient, and to the state of the pulse. But, with that gentleman, we are also convinced, that there are no symptoms which characterize a distinct class of apoplectic affections requiring any important modification in the treatment; or, in other words, a class which, in their nature, do not admit of blood-letting; while in most cases of the disease, we repeat, the free use of the lancet is almost the only means by which the life of the patient can be saved, or his permanent decrepitude prevented.

Subsequently to general blood-letting, and more especially if the symptoms of the case have not been very decidedly ameliorated, the local abstraction of blood should invariably be resorted to; by the application of cups or of leeches to the temples, occiput, nape of the neck, or to the shaved scalp. Cruveilhier advises leeching along the course of the jugulars; but as a general rule, admitting of few exceptions, we should prefer the application of cups to the head or back part of the neck. The cups, when scarifications are freely made, draw off the blood much more promptly than leeches, and the irritation which they produce, has often appeared to us to act beneficially, by unloading the vessels of the brain. Gregory has seen the application of cups rouse the patient, when bleeding from the arm had been productive of apparently no effect. Dreysig notices the same fact (*Handwörterbuch der Med. Klin.* I. 450.), and it is confirmed by our own experience.

In cases of apoplexy, Cruveilhier is in the habit of drawing blood from the mucous membrane lining the nostrils, either by scarifications, or by the application of leeches within the nose; and he bears very decided testimony in favour of its advantageous effects. (*Méd. Clinique.* 1821.) In consequence, also, of the beneficial change frequently produced in the symptoms of the disease by spontaneous discharges of blood from the hæmorrhoidal vessels, that gentleman suggests the propriety of applying leeches to the margin of the anus. The detraction of blood from this part, will, no doubt, often be attended with the very best effects.

In regard to the extent and repetition of topical depletion, much must be left to the judgment of the practitioner, it being impossible to lay down any general rule in relation to it. The effects produced by the previous bleeding, and the character of the symptoms which remain, must be taken into account in deciding upon the suspension or continuance of the remedy.

2. *Cold Applications.* We have already advised the head of the patient to be shaved, and the scalp to be then covered with cloths wet with iced water. The application of the latter should invariably be resumed after the cupping, and persevered in so long as symptoms of cerebral irritation and congestion, with heat of the head and flushed and tumid countenance continue. In violent attacks, the application to the head, of even powdered ice inclosed in a bladder, will be advisable. Abercrombie recommends, whilst the patient is supported in a sitting posture, a stream of cold water to be poured upon the crown of the head and received in a basin held under the chin. He gives an example of a girl quickly restored by this means, from a state of what he believed to be decided apoplexy. Of the beneficial effects resulting from the sedative impression of cold applied to the scalp in all cases of apoplexy, there cannot be a doubt. For the simple forms of the disease, it may almost be ranked, in consequence of the promptness of its action, upon a level with direct depletion. (Cruveilhier, Thilenius.) In general, as soon as the temperature of the head becomes natural, and the fullness of the features entirely subsides, especially if at the same time they become pale, the cold applications may be omitted; but on the return of heat or of a flushed appearance of the face, they should be immediately resumed. Even after the comatose symptoms have disappeared, frequently sponging the head with cold water, the hair being at the same time kept short, will be found of decided advantage.

3. *Counter-Irritants.* Simultaneously with the application of cold to the scalp, counter-irritants to the lower extremities, in the form of sinapisms, or stimulating liniments, may be resorted to with good effect. In relation to the use of these remedies in apoplexy, some little difference of opinion, however, exists among practitioners; some objecting to them entirely as injurious, while others consider them as of little or no benefit. But the weight of experience is in favour of their early employment in all cases of the disease. With Cruveilhier, we are persuaded that it is during the presence of the comatose symptoms, that their good effects will be the most decided.

4. *Purgatives.* After blood-letting, the most powerful remedy in cases of apoplexy is, unquestionably, active purgation. In regard to its beneficial effects and its general propriety in all cases of the disease, less difference of opinion exists than in relation to almost any other remedy that has been proposed. Abercrombie relates several cases in which little effect seemed to result from blood-letting, whereas an evident improvement took place immediately after copious alvine evacuations were procured. Johnson states that his experience is in unison with this observation (*Med. Chirur. Rev.* I. 24.), and we can say the same. To obtain a free and copious discharge from the bowels should, therefore, be attempted at as early a period as possible of the attack. In severe cases it is always difficult, however, often impossible, to cause the patients to swallow any medicine given by the mouth; hence, as a general rule, immediately after the first bleeding, an active purgative enema should be administered, and repeated at short intervals, until a full evacuation from the bowels is procured. The article most readily obtained is, perhaps, soft soap, of which two or three table-spoonfuls may be dissolved in a pint or more of warm water, for an injection; and, if requisite, its activity may be increased by the addition of common salt or a strong infusion of senna leaves in combination with the sulphate of magnesia or soda; a solution of aloes in warm water; or any other of the usual purgative enemata, may be employed. In many cases, an injection of a drachm of spirits of turpentine suspended in mucilage of gum acacia or thin starch will be found very prompt and active in its operation. Cruveilhier recommends adding to the injection made use of, a small quantity of tartarized antimony, so as to obtain its depressing effects upon the circulation without exciting vomiting. Richter even advises injections of a solution of tartar emetic; we should strongly doubt their propriety, however. Irritating enemata are enjoined by Aretæus and Forestus, and by many, also, of the modern writers, particularly Thilenius. Free catharsis may sometimes be produced by placing a drop or two of Croton oil upon the patient's tongue; we have repeatedly seen it produce no effect, however, when used in much larger doses, and when purgative enemata have operated effectually.

The moment the patient can be made to swallow, a large dose of calomel and jalap or other active cathartic, followed, after a short interval, by an infusion of senna, or by purgative injections, should invariably be prescribed. But it is not merely necessary to purge during the early period of the attack; the bowels should be also kept in a lax condition so long as the disease continues, by the judicious administration of purgatives at proper intervals. The one from which we have derived the most advantage is the compound powder of jalap.

When the attack has succeeded to the sudden cessation of a hæmorrhoidal discharge, some advantage is supposed to result from a combination of aloes, soap, and the blue mass, or of aloes and colocynth or scammony.

After the attack is so far mitigated that the patient has recovered the power of deglutition, Copland states that he has often seen decided advantage derived from a mixture of half a drachm of spirits of turpentine and the same quantity of castor oil; particularly when the bowels are required to be freely acted upon. If necessary, the same dose may be repeated a second or third time, at intervals of from twelve to twenty-four hours. This prescription, he remarks, will promote a more complete revulsion from the head than any other means that can be employed, particularly when preceded by calomel or other cathartics, and followed by active enemata. (*Dict. Pract. Med.*)

5. *Blisters.* By Cullen and some later writers, the early application of a blister to the scalp or nape of the neck is strongly recommended in the treatment of apoplexy, while by others, the practice is as strongly reprobated. The decision on this question must be drawn from the general result of experience, and this appears to be in favour of the remedy; a very great discrepancy of sentiment exists, nevertheless, as to the stage of the disease when their effects are most beneficial. Cruveilhier considers them proper only during the comatose stage, and others restrict them to a later period of the attack. Most of the more recent writers, also, with Portal condemn their application to the scalp, and we think with great propriety. Judging from the facts that have fallen under our own notice, we should say, that blisters ought not to be resorted to, until after depletion by the lancet and by cups has been pretty actively employed: subsequently, however, much advantage will certainly be derived, in many cases, from blisters applied to the nape of the neck, between the shoulders, or on the inside of the thighs or legs.

6. *The Actual Cautery or Moxas. Setons and Issues.* These have all been advised, from a very early period of our science, in the treatment of apoplexy. The first may be useful, occasionally, in desperate cases; especially when the stupor continues, after a fair trial has been made of the remedies already detailed. The two latter can scarcely be considered proper, excepting as prophylactic measures, or in the consecutive treatment of the disease.

7. *Frictions of the Skin.* These are strongly recommended by CRUVEILHIER, as well during the comatose stage as subsequently. He directs them to be made with a flesh-brush, or the hand, over the whole surface of the body. ABERCROMBIE, also, speaks of their good effects in the most positive terms. The remedy certainly deserves attention. We are convinced it will be found particularly useful after the patient is roused from the state of deep stupor with which the attack generally commences.

8. *Emetics.* To determine how far the employment of emetics is useful in apoplexy, or even whether they are at all admissible, would be very difficult were we to content ourselves with merely collating the discordant opinions of different writers on the subject. While by one class the good effects of emetics are insisted upon in the most positive terms, during particular stages, or, at least, in certain forms of apoplexy, by another they are as positively denounced as invariably a doubtful, and often a decidedly injurious prescription in every stage and variety of the disease. On both sides of the question, we find arrayed, in nearly equal proportions, many of our most distinguished medical authorities. Notwithstanding this decided opposition of opinion, founded in a great measure upon hypothesis, and deriving little or no support from facts, we conceive that the question may be very readily settled by an attentive consideration of the phenomena generally attendant upon the apoplectic attack, compared with the best established views in relation to its pathology, and the well-known immediate effects produced by the operation of the remedy. In the general run of cases, there is certainly nothing in the symptoms of apoplexy indicating the necessity of a resort to emetics, while from the condition of the brain during the attack, and the flushed and tumid face, bloodshot eyes, and other symptoms of an interrupted circulation in the vessels of the head, ordinarily observed during the act of vomiting, the impropriety of their employment would appear to be clearly pointed out. It may be added, also, that in the predisposed, the apoplectic seizure has been brought on, not unfrequently, by the violent straining often attendant upon the operation of an emetic. We have no hesitation, therefore, with CULLEN, WALTHER, CHEYNE, CRUVEILHIER, the elder RICHTER, PORTAL, ROCHOUX, SERRES, and the greater part of the recent writers on the disease, in proscribing emetics entirely from the treatment of genuine apoplexy. It is remarked by PORTAL, that in violent cases, previously to the compression being removed from the origin of the nerves, emetics, even in the largest doses, will frequently have little or no effect upon the stomach.

A state of coma does, however, occasionally occur, strongly simulating that of apoplexy, in which the operation of an emetic is certainly decidedly beneficial. The attack, in the instances to which we refer, always takes place a short time after eating voraciously or immoderately of rich and indigestible food, and seems to be induced solely by the over-distension and irritation to which the stomach is thus subjected. For, when the contents of the latter are evacuated, either by spontaneous vomiting or by the exhibition of an emetic, the coma almost instantly disappears, and leaves, in general, the patient free from any symptoms of cerebral disease. If, however, relief be not in this manner obtained at an early period of the attack, all the phenomena of genuine apoplexy are developed, as we have had occasion to witness in more than one instance.

In these cases of spurious apoplexy, as they have been termed by some writers, the patient, immediately after eating, is suddenly deprived of sense and motion, and lies as one in a state of syncope; the face is pale; the eyes are fixed and staring; the pulse small, weak, and frequent; the breathing without stertor, slow and scarcely perceptible; the surface of the body is often cool and clammy. When the epigastrium is examined, it is found tense and greatly distended. Although in such cases, we would always advise the prompt administration of an emetic, we should not, however, neglect, at the same time, the application of cups and of cold to the head, and the immersion of the feet in hot water, followed by sinapisms to these parts.

9. *Stimulants.* It has been usual, remarks CULLEN, for practitioners, together with the remedies already enumerated, to

employ various kinds of stimulants; but I am disposed to think them generally hurtful; and they must be so whenever the fullness of the vessels and the impetus of the circulation are to be diminished. Upon this principle it is therefore agreed that stimulants are absolutely improper in what is supposed to be sanguine apoplexy; but they are commonly believed to be proper in the serous. If, however, we be right in alleging that this also commonly depends upon a plethoric state of the blood-vessels of the brain, stimulants must be equally improper in the one case as in the other. (*First Lines.* § 1135.) Notwithstanding the use of stimulants is advocated by medical writers of a very late date, in certain stages and forms of apoplexy, yet, the judgment pronounced by Cullen in relation to their employment, is so perfectly in accordance with our own views, generally speaking, of the nature and treatment of the disease, that we need add nothing to it: under all circumstances, and at all periods of apoplexy, we consider their administration to be in the highest degree hazardous; often they cannot fail to prove eminently injurious. The principal of the recent writers who advise the use of stimulants are Richter (*Med. Chirurg. Bemerk.* II. 110.), Cooke (*Nervous Diseases.* I. 337.), Abercrombie (*Researches on the pathology of the brain in apoplexy*), and Copland. (*Dict. Pract. Med.*)

From what has been said, it must be evident, that during a fit of apoplexy, our chief dependence for its removal, must be upon prompt and active depletion by blood-letting, general and topical, and purgatives, regulated in extent and repetition by the violence of the symptoms and the age and constitution of the patient; in conjunction with a proper position of the body, cold to the head, and counter-irritants to the extremities. It will be proper, in all cases also, to inquire into the state of the urinary discharge, lest injury result from accumulation of urine in the bladder, which should be prevented by an immediate resort to the catheter.

When consciousness has returned, and the patient is recovered from the immediate effects of the attack, the state of the pulse, the remaining symptoms, the general condition of the different functions of the system, and the extent to which, also, depletion has been already carried, will indicate the subsequent treatment which is to be adopted. The patient should invariably be preserved in a state of the most perfect quietude both of mind and body; all unnecessary exertion, or excitation of either, is therefore to be carefully avoided. If any food be allowed, it should be very sparing in quantity, and of the least irritating quality; it would be better, in fact to confine the patient for some time to toast-water, water gruel, or thin panado and even these should be sparingly indulged in. Flesh, and vinous, malt, or spiritous liquors, must be strictly and absolutely prohibited. A laxative condition of the bowels should be preserved by the occasional administration of active purgatives and injections. The remaining symptoms will frequently indicate the necessity of a repetition of blood-letting, especially topical bleeding by means of cups or leeches to the head. In many cases, also, some advantage will be derived from antimonials, especially in combination with the blue mass. Keeping the hair short, and frequently sponging the scalp with cold water; as well as brisk and repeated friction of the whole surface of the body, are important measures, that ought never to be neglected. The patient, likewise, should sleep, at night, on a hair mattress, with his head and shoulders considerably elevated.

The symptoms which succeed to the attack of apoplexy have a close relation to the changes which take place at the seat of lesion in the brain. The absorption of the effused blood, and the process of cicatrization in the apoplectic cavity, require, ordinarily, several months for their completion; during the whole of which period the patient is in imminent danger of a recurrence of the disease from very slight causes. The utmost care therefore should be observed to prevent inflammation from taking place around the extravasated blood, and thus occasioning a return of the congestion and hemorrhage. According to Cruveilhier, about the eighth day after the attack is generally the most critical period, as it is then that inflammation of the parietes, or in the immediate vicinity of the apoplectic cavity, is most liable to occur; with either a renewal of the hæmorrhage, effusion of serum between the membranes or into the ventricles, or extensive softening of the brain. Hence the great importance of preserving the patient in the utmost quietude of body, stillness and silence, until subsequent to that period; disengaging his senses, passions, and mental faculties, from all undue excitement; keeping him upon a low abstemious diet, and promptly reducing, by appropriate measures, any tendency that may be detected, however

slight, to a renewal of the cerebral irritation and congestion. Caustic issues, or setons, to the nape of the neck, or in the neighbourhood of the cervical vertebræ, or the use of tartar emetic ointment, so as to keep up, for a considerable time, a pustular eruption on the part to which it is applied, will often be found beneficial measures. Any symptoms of gastro-enteric disease that may present themselves, ought to be carefully attended to, and removed as speedily as possible by an appropriate course of treatment. Indeed, a healthy condition of all the functions of the body will materially aid in the removal of any morbid condition of the brain that may exist, and promote the perfect cure of the apoplectic patient.

Even though the patient should recover promptly the full power of his mental faculties, and the strength and free exercise of his muscles, he must recollect that his safety from a renewal of the apoplectic attack will depend in a great measure upon the caution which he observes, at all times, subsequently, to guard against the predisposing and exciting causes of the disease. He must observe the strictest temperance both in eating and drinking, the entire abandonment of all stimulating food and drinks; he must make use of moderate but regular exercise in the open air; sedulously avoiding the least approach to bodily or mental fatigue, and all undue excitement of the feelings or passions; he must be careful of exposing himself to the extremes of heat or cold, or to wet and damp. The preservation of the bowels in a free state by regular habits, a laxative, chiefly vegetable diet, mild purgatives or injections, is all-important; as well as early rising, the avoidance of nightly assemblies, and of crowded and heated apartments, whether in the day or at night.

When paralysis persists after the removal of all the other symptoms of the apoplectic attack, a particular course of treatment will be demanded. The present is not the proper place, however, to enter upon its consideration; it will be fully pointed out in the article *Palsy*, to which the reader is referred.

Prevention. It has been correctly observed by an ancient writer, that it is always of more importance to prevent than to cure a disease. The importance of preventive measures is very greatly increased in relation to those affections which, like apoplexy, are so frequently fatal, under the best devised treatment, and which, even when not destructive to life, may

leave the patient a comparatively helpless invalid for the remainder of his existence. To prevent the occurrence of apoplexy may not, it is true, be possible in all cases; but in a very large majority, we are convinced, that an attack of the disease may be entirely warded off by a prudent attention to diet and regimen; or even after a predisposition to it has been acquired, this may be destroyed by the same means, in addition to the use of such remedies as are calculated to reduce the plethoric state of the system, and counteract the tendency in the brain to irritation and engorgement.

The prevention of apoplexy, therefore, will depend upon a careful avoidance, as far as practicable, of all its predisposing and exciting causes. One of the most certain securities against the occurrence of the disease is a constantly temperate, regular, and active mode of life—equally removed from luxurious indolence on the one hand, and from the cares and privations of abject poverty on the other. I cannot, remarks Lancisi, too frequently repeat, that we search in vain for a preservative against the attacks of disease in the operation of medicines, when we neglect the rules of a rational hygiene. The remedies of the physician are deceitful; there is but one preventive alike efficacious at all times and under every variety of circumstance, and this is to be found in a wisely ordered course of life, and in the possession of that happy calm of mind which is neither troubled by the sunshine of success nor by the storms of adversity.

By those persons whose form and habit of body predispose them to apoplexy, the most scrupulous care must be observed. Their diet must at all times be spare and composed chiefly of vegetables, and their drink, water. They must rise and retire early, and use daily a considerable amount of active exercises, avoiding, however, undue fatigue and exposure to extreme cold or intense heat, and all close or prolonged application of the mind, and every excitement of their passions. Frictions of the surface of the body, cold sponging of the head, and the preservation of a regular state of the bowels, are likewise important preventive measures. The clothing should be loose, and especially should all ligatures about the neck, chest, and abdomen, be cautiously avoided. If the individual be affected with any chronic discharge from the body, whether of blood, pus or serum, he should be extremely cautious not rashly to arrest it. All those positions of the body which have a tendency

to impede the free passage of the blood from the head are to be guarded against. If at any time, pain or a sense of heaviness or over-fullness of the head, flushing of the face, temporary dimness of vision or dullness of hearing, an unusual lethargy or tendency to sleep, a numbness of one side of the body or face, or of the hands or feet, a difficulty of utterance or embarrassed state of the tongue, should occur, no time must be lost in resorting to blood-letting, cold applications to the scalp, active purgatives, sinapisms to the feet, and an abstemious diet. When the above premonitory symptoms frequently recur or are readily excited, the insertion of an issue or seton into the back of the neck, or the use of the tartar emetic ointment so as to keep up a permanent irritation, after cups or leeches to the temples or occiput, or leeches to the anus, will be advisable. All intellectual occupation, and every excitement, whether of mind or body, must at the same time be most sedulously avoided.

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APOPLEXY OF THE LUNGS, &c. Some modern pathologists, under the persuasion that the best means of advancing our science is to group together diseases according to their organic lesions, employ the term apoplexy as a generic one, to signify all spontaneous effusions of blood into the parenchyma of the organs or tissues. Thus they speak of cerebral, meningeal and spinal apoplexies, of apoplexy of the lungs, heart, muscles, liver, spleen, uterus, placenta, kidney, pancreas, testicle, skin, mucous and serous membranes, cellular tissue, &c. But the term apoplexy was originally applied to a determinate group of symptoms, and not to designate a particular organic lesion; and as we do not perceive the advantage or necessity of diverting it from its original signification, we shall use this epithet in the sense only in which we have hitherto employed it (see p. 201.). The diseases to which the epithet apoplexy of the lungs, heart, &c., has been bestowed, will be discussed in the articles on the pathological states of those organs. I. H.

APOPLEXY OF NEW-BORN INFANTS. (See *Asphyxia.*)

APOSTASIS. (From απο, from, and ιστημι, I stop.) The ancients employed this in several significations:—1. as synonymous with abscess; 2. to designate the separation of bones by fracture; 3. to signify the solution of a disease by some secretion. I. H.

APOSTEMA. (From αφιστημι or αφισταμαι, I recede from.) This word was employed by the ancients in a general and vague signification. They seem to have used it to designate an affection in which parts, previously in contact, are separated by a fluid collected between them. At the present moment its signification is no better defined than formerly; but it is for the most part employed as synonymous with *Abscess* (q. v.). I. H.

APOZEM. (From αποζειν, to boil.) αποζημα, Gr.; *Apozema*, Lat. A compound officinal preparation, the basis of which is an aqueous infusion or decoction of one or more vegetable substances, to which various other simple or compound medicines, as manna, salts, syrups, electuaries, tinctures, or extracts, are added. Apozems are always compound, which distinguishes them from simple decoctions; and they are always taken at stated periods, and never as ordinary drinks, in which they

differ from tisans. These preparations, which may be traced to the extravagancies of Galenical pharmacy, have within the last thirty years been gradually falling into disrepute, and are now but little employed. I. H.

APPARATUS. (From *parare*, to prepare.) *Appareil*, Fr. Anatomists and physiologists employ this term to signify an assemblage of organs concurring in the performance of the same function,,and the actions of which have a common object. Thus, the mouth, œsophagus, stomach, intestines, liver, and pancreas, constitute an organic apparatus, each part performing its particular office, in effecting the digestion of food, which is the result of their conjoined actions.

In surgery, this epithet is bestowed upon the instruments and dressings required in operations. It has also been applied to the different methods of operating for stone.

In pharmacy, chemistry, &c., it signifies a collection of the instruments employed in these sciences, for any particular object. I. H.

APPENDICULA. The diminutive of Appendix. I. H.

APPENDIX. (From *appendere*, to hang to.) A part added to, or connected with another. An appendix is always situated exteriorly to the principal body, and is of less size than this last. Thus, the vermicular process arising from the cœcum is termed the vermiform appendix. The Fallopian tubes are appendices to the uterus, &c. I. H.

APPETENCE, APPETITE, APPETITION. (From *appetere*, to desire.) In their most extensive acceptation, these words signify those internal sensations which impel to certain actions, for the gratificatiou of the wants of the organism. The appetites are produced by inappreciable modifications, the seat of which determines the particular appetite; thus, when located in the stomach, fauces, or genital organs, we have hunger, thirst, or venereal desires.

The word appetite is also very generally used in a more restricted sense, to signify the desire for food, or synonymously with hunger. Physiologists have, however, attempted to establish various distinctions between appetite and hunger; thus it is said that the former is only the first degree of the latter; that appetite is an agreeable sensation which promises pleasure, and hunger an imperious want, difficult to support, and which soon becomes painful if not satisfied; that the former is more delicate and capricious than the latter, and to be awakened requires a freedom of choice in food, whilst the latter is less exacting as to the quality than the quantity of food. It has also been proposed to restrict the term appetite to the artificial desire, or that which recurs at the period at which the stomach is accustomed to receive food, and hunger to the natural desire. These distinctions have not been sanctioned by general adoption, and it is only in the general and restricted significations we have given, that the word can with propriety be employed. But though this double acceptation is too firmly established by common usage to be altered, still science demands a greater precision in the use of terms, and we shall accordingly, in the present article, employ the one in question, only in its most extensive signification; and refer the several appetites to their appropriate heads. (See *Hunger*, *Thirst*, &c.)

The appetites being the expression of the wants of the organism, recur with the renewal of these wants, at longer or shorter intervals, often periodically, varying with temperature, sex, season, climate, habit, &c. At their commencement, they are rather pleasurable than otherwise; but if not satisfied, they are converted into imperious wants, become painful, and occasion various derangements of the organism. (See *Abstinence*, and *Continence*.)

The appetites are subject to variable pathological states: they may become exalted, constituting *Bulimia*, *Satyriasis*, and *Nymphomania*, or, diminished, *Anorexia*, and *Aphrodisia;* and finally, depraved, as in *Pica* and *Malacia*. (See these several heads.) I. H.

APYRETIC. (From α priv. and πυϱ, fire.) απυρετος, Gr.; *Apyreticus*, Lat. Without fever. I. H.

APYREXIA. (Same etymology.) Absence of fever. It is most commonly employed to designate the interval between the paroxysms of intermittent fevers; though some authors apply it also to the cessation of fever on the decline of acute diseases. (See *Intermittent Fever*.) I. H.

AQUEDUCT. Properly a canal for the transmission of water. Anatomists have applied it to certain canals.

Aqueduct of Fallopius. *Canal spiroide de l'os temporal.* A canal in the petrous portion of the temporal bone, extending from the internal meatus to the styloid foramen, and giving passage to the facial nerve.

Aqueduct of the Vestibule. *Aqueduct of Cotunnius.* A canal commencing in the vestibule near the common orifice

of the two semicircular canals, and opening at the posterior face of the petrous portion of the temporal bone.

AQUEDUCT OF SYLVIUS. *Iter ad quartum ventriculum*, *Canalis medius*, *Canal intermédiare des ventricules* of CHAUSSIER. Canal forming a communication between the third and fourth ventricles of the brain. I. H.

AQUEOUS. (From *aqua*, water.) Watery.

AQUEOUS HUMOUR OF THE EYE. The limpid humour which fills the two chambers of the eye. (See *Eye.*) I. H.

ARACHNOID. ARACHNOID MEMBRANE. (From αραχνη, a cobweb, and ειδος, like.) αραχνοειδες, Gr.; *Arachnoideus*, *Tunica aranea*, Lat. This epithet was given by the ancients to several membranes which from their excessive tenuity resemble spider-webs. Thus the hyaloid membrane, and capsule of the crystalline, were thus denominated. It is now exclusively applied to the membrane of the brain and spinal cord situated between the dura mater and pia mater. (See *Brain*, *Spinal Cord*, and *Serous Membranes.*) I. H.

ARACHNOIDITIS. Inflammation of the Arachnoid. (See *Meningitis.*) I. H.

ARALIA. (*Mat. Med.* and *Botany.*)

Sex. Syst. Pentandria, pentagynia. *Nat. Ord.* Araliaceæ.

Gen. Ch. *Calyx* five-toothed or entire; *Corolla* five-petalled; *Stamens* five, often more; *Styles* five, spreading; *Berry* 5–10 seeded, crowned with the styles; *Umbels* often with small involucres. BECK.

This genus forms the type of the natural order ARALIACEÆ, which includes *Panax*, differing from this only in having five styles instead of two or three, and in the fruit being five-celled. All the species are possessed of medicinal properties; two of them have been recognized in the U. S. Pharmacopœia as officinal, the *A. nudicaulis* and *A. spinosa*. Another of the North American species, the *A. racemosa*, also appears to be endowed with no inconsiderable therapeutic qualities, and has been favourably spoken of as an application to chronic ulcers, and, according to MICHAUX, was held in great repute among many of the Indian tribes, as a sudorific.

Of the Asiatic species little is known except the short notice of them given by LOUREIRO (*Flor. Cochin.*), from which it would seem that they are very analogous in their remedial powers, to those found in the United States.

1. *A. nudicaulis.* Spikenard. False Sarsaparilla, &c.

Sp. Ch. Nearly stemless; *Leaf* mostly solitary, triquinate, leaflets sessile, oblong, oval, acute, serrate, smooth; *Scape* shorter than the leaf, three-cleft at the top; *Umbels* few, small, on long peduncles, without involucres. BECK. This plant occurs from Maine to Georgia, but is most common in the northern and middle States. It is usually found in rocky woods in a good soil; flowering about the end of May and beginning of June. The root, which is the most active part, is perennial, horizontal, of a brown colour, cylindrical, more or less twisted; possessing a fragrant, balsamic smell, and a warm, aromatic, sweetish taste. It is known in many parts of the United States by the name of Sarsaparilla, the root closely resembling that article, and possessing much the same properties, being a mild stimulating diaphoretic and alterative, and may be advantageously substituted for it. It is much used in some parts of the country, in rheumatic, venereal, and cutaneous affections. Dr. MEASE states that a watery infusion has been found useful in zona, and also as a tonic in dyspepsia. The doses and mode of administration are the same as those of Sarsaparilla.

2. *A. spinosa.* Angelica. Prickly Elder, &c.

Sp. Ch. Arborescent; *Stem* and *Leaves* prickly; *Panicle* much branched; *Umbels* racemose. PERSOON. This species is found from New-York to Florida, but is most common in the southern and western States. It chiefly occurs in low, fertile woods, flowering in August and September. It is an arborescent shrub, growing to the height of ten or twelve feet; furnished with numerous rigid prickles; the leaves, which occur near the top, are large, bipinnate or tripinnate, and prickly; the leaflets are oval, acute, and serrate. The flowers are in terminal panicles, formed of small umbels. The bark, root, and berries, are all medicinal, but the first only is recognized by the Pharmacopœia. This is thin, of a grayish colour externally, and yellow-white within; its odour is aromatic, and its taste bitterish, pungent and acrid. It is much more stimulating than the last mentioned species, but is used in the same affections. Dr. MEASE states that the watery infusion, when employed as a diaphoretic, should be made very weak, as it is apt to create nausea and cause great irritation of the salivary glands in some persons. According to

ELLIOTT, the infusion of the recent root is emetic and cathartic. A tincture of the berries is said by PURSH to have been successfully used in rheumatism: from its effects on the salivary glands, it has also been found useful in tooth-ache.

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R. E. GRIFFITH.

ARBOR VITÆ. The arborescent appearance exhibited by a longitudinal section of the cerebellum; and which results from the particular arrangement of the white substance with the cineritious.

I. H.

ARBUTUS. (*Botany.*) *Arctostaphylos*, ADANSON.

Sex. Syst. Decandria Monogynia.—*Nat. Ord.* Ericeæ.

Gen. Ch. *Calyx* five-parted. *Corolla* ovate, with a five-cleft orifice; pellucid at base. *Berry* five-celled.

A. Uva Ursi.—Bearberry.—Busserole, Raisin d'ours, Fr.; *Bärentraube*, Germ. —*Sp. Ch.* "Stems procumbent, leaves entire." LINDLEY. This is an evergreen shrub, with trailing stems from one to three feet long, the younger branches of which rise obliquely upwards at their extremities. The leaves are scattered, thickly set, upon short footstalks, obovate, acute at the base, entire, coriaceous, smooth, shining and of a deep green colour on the upper surface, paler and covered with a net-work of veins on the under. The young leaves are often pubescent. The flowers, which appear in May and June, are disposed in small terminal racemes, upon short, red, reflexed peduncles. The calyx is five-parted, with obtuse segments, and persistent. The corolla is ovate, whitish or reddish-white, transparent at the base, contracted at the mouth, and divided at the margin into five short, reflexed, red segments. The fruit is a round, depressed, smooth, glossy, deep-red berry, about as large as a pea, and containing a white, insipid, mealy pulp, with five cohering seeds.

The Uva Ursi is a native of the northern parts of Asia, Europe, and America. It inhabits also the mountains of the south of Europe, and extends, on the continent of North America, from Hudson's Bay as far southward as the middle States, growing abundantly in some parts of New-Jersey. It prefers a dry, barren soil, and is found in sandy woods, on gravelly hills, and on elevated sandy plains. The fruit is sometimes eaten, and the leaves are said to be used in Russia for tanning. The portion of the plant medicinally employed is the leaves. (See *Uva Ursi.*)

Two other species of Arbutus are noticed by medical writers. The leaves and twigs of the *A. Alpina*, a small shrub growing in the mountains of Switzerland and the Tyrol, and in various parts of the north of Europe and America, have been used as an astringent; and the berries, which are black, of the size of cherries, and of a somewhat harsh, acidulous taste, have been eaten as food. The *A. Unedo*, or *strawberry-tree*, a native of the south of Europe, is an evergreen shrub, seven or eight feet high, with a fruit which is beautifully red when ripe, and in size and appearance bears considerable resemblance to the strawberry. It has a sweetish acidulous taste, and, though not very agreeable, is eaten by the natives of the countries where the plant grows. By fermentation it affords an alcoholic liquor from which a spirit is obtained by distillation, sometimes used in Italy and Spain. The leaves and bark are astringent.

GEO. B. WOOD.

ARCHÆUS. (From αρχη, principal, chief, commencement.) This term was coined by BASIL VALENTINE, to designate the universal principle, the central fire which, according to this chemist, constitutes the source of vegetable life. It was subsequently employed by PARACELSUS to signify the *primum mobile* of the animal organism, and of nature in general—the vital principle, which differs from all chemical forces—a spiritual essence, distinct from matter, and which in animals has its seat in the stomach, where it is incessantly occupied in converting alimentary matters into blood. According to him, there is no other vital principle than the archæus, which presides over all the changes in human bodies, and alone cures diseases, the physician merely assisting in this process.

These crude views were subsequently seized upon by VAN HELMONT, extended and erected into a doctrine which, variously modified by GLISSON, STAHL, HOFFMAN, and CULLEN, has descended to our own days, with the title of vitalism (q. v.).

The archæus, as depicted by VAN HELMONT, is an active, intelligent, immaterial principle, pervading all matter, the molecules of which it separates, changes, en-

dows with new properties, and keeps in continual motion; which constitutes life. This archæus is equivalent to the ενοςμων of HIPPOCRATES and GALEN, the sentient soul of PLATO, the nature of some authors, the nervous power of others, the soul of STAHL, the vital force of BARTHEZ and CHAUSSIER, the vital properties of BICHAT, &c. VAN HELMONT imagined the archæus to have its seat at the superior orifice of the stomach, whence, as from its throne, this king of the organism directed all the phenomena of life. Besides the principal and dominant archæus, the writer last mentioned conceived that there existed a subaltern archæus in each viscus, whose office it was to receive and execute the orders of the principal one. To that of the spleen he attributed great importance, and considered it, with that of the stomach, as constituting a ruling duumvirate. He further imagined that the archæus had volition, and was affected with anger, fright, and other emotions. So long as it remained unmoved, and the subordinate archæi faithfully executed its orders, the harmony of the system was preserved, or, in other words, there existed perfect health. But when one of the subaltern archæi roused to passion, either from caprice, or the unusual resistance of the articles subjected to its immediate orders, the ruling archæus, irritated by such audacity, united its subordinates against the rebellious one, which too often, however, drew a part of these last into the revolt. The spiritual empire of the human body is then a prey to all the horrors of anarchy; each party precipitates the actions it directs, and thus provokes a tumult which constitutes disease. The same thing happens when the principal archæus yields to a sally of passion, from which he is not exempt, and which induces a host of irregularities.

The principal object in the therapeutics of VAN HELMONT was to calm or stimulate the archæus and regulate its movements. The further exposition of this doctrine would be misplaced here, and involve repetition, since it must necessarily be discussed in the article *Vitalism* (q. v.).

I. H.

ARCTIUM. (*Botany* and *Mat. Med.*)

Sex. Syst. Syngenesia Æqualis. *Nat. Ord.* Compositæ.

Gen. Ch. Involucre globose, each of its scales with an incurved hook at the extremity. *Receptacle* chaffy. *Pappus* simple, the rays short. BECK.

A. lappa. Burdock. *Bardane*, Fr.; *Gemeine Klett*, Germ. *Sp. Ch.* Leaves cordate, petiolate, unarmed. LINN.

This plant is not a native of the United States, though it is common in most parts of the Union, growing on road-sides, on rubbish and in waste places; flowering in July and August. It is a biennial, with a succulent, pubescent stem of two or three feet in height, branching towards the summit, and furnished with large, cordate leaves supported on long petioles. The flowers are purple, and globose. The involucre is formed of imbricate scales, each of which terminates by a hooked bristle by which the seed-vessels attach themselves to sheep and other animals, and are thus widely dispersed. The root is simple and fusiform, about a foot in length, of a blackish-brown colour externally, and white and spongy within. By the process of drying, it loses about four-fifths of its weight. Its smell is unpleasant, though faint; its taste is mucilaginous, with a little bitterness and astringency. No exact analysis of this plant has been made. GUIBOURT has detected inuline in the root, and FEE states that sugar also enters into its composition. The ashes yield about one-third their weight of potash.

The root is the part most generally employed in medicine, though the leaves and seeds have likewise been recommended. The root is said to be diaphoretic, depurative, and diuretic. WITHERING states that many eminent practitioners considered it equal if not superior to sarsaparilla, but CULLEN denies its powers as diaphoretic. In Poland, however, it is said by BODARD (*Mat. Med.* II. 132.) that the decoction has been advantageously prescribed in syphilis. From the concurrent testimony of those who have investigated its real powers with care, it appears that the decoction of the root of this plant acts as a mild alterative, gently exciting the cutaneous exhalants, though it is not entitled to the rank of a diaphoretic. ALIBERT has found it useful in cutaneous affections attended with dryness of the skin. The decoction is made by boiling two ounces of the recent bruised root in three pints of water down to two; of this a pint or more is to be taken during the day.

The leaves have been used as applications to ulcers and some of the leprous eruptions, either simply bruised or in the form of a strong decoction. The seeds, which have a bitter and somewhat acrid taste, have been recommended as powerfully diuretic, when taken either in the form of an emulsion or a powder, in doses of about a drachm. LINNÆUS and DECANDOLLE state they also possess purgative properties.

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R. E. Griffith.

ARDENT. (From *ardere*, to burn.) Burning, or causing great heat.

Ardent fever. Causus, Synocha, or Inflammatory fever. (See *Fever.*) I. H.

ARDOR. A sensation of burning or violent heat. I. H.

ARECA. (*Botany.*)

Sex. Syst. Monoecia Monadelphia.—*Nat. Ord.* Palmæ.

Gen. Ch. *Common spathe* one or two-valved.—Male. *Calyx* three-parted. *Corolla* three-petalled. *Stamens* cohering at the base.—Female. *Calyx* three-leaved. *Corolla* three-petalled. *Nectary* six-toothed. *Styles* three, very short. *Drupe* one-seeded.

A. Catechu. — *Sp. Ch.* "Fronds pinnated; leaflets plaited, terminal bitten off; stem and spadices smooth." Lindley. The Areca Catechu is a beautiful palm, from twenty to forty or even fifty feet high, with a straight, erect, round, smooth, ash-gray trunk, about six or eight inches in thickness, marked, at short intervals, with parallel rings left by the falling leaves, and surmounted with a crown of foliage, consisting of very large pinnate leaves, proceeding in all directions from the stem. The flowers are small and disposed in panicles, the male being situated upon the upper portion of the branches, the female at their base. They are at first inclosed in a large, green, axillary spathe, which falls with the falling foliage, and leaves them beneath the leafy crown at the summit. They are succeeded by fruit of a reddish-yellow colour becoming grayish at perfect maturity, of the shape and size of a large plum, having the persistent calyx and corolla at the base, and inclosing, in a fibrous fleshy envelope, a roundish conical nut, the shell of which is brittle and adheres to the exterior flesh. On the same plant there are usually, at the same time, flowers and fruit in all stages of development.

This palm is a native of Hindostan and other parts of the East Indies, where it is highly valued on account of its fruit. This is very astringent, and, in connexion with the leaf of the Piper Betel and with lime, constitutes the masticatory so well known under the name of betel, and so extensively used throughout the East Indies, where it enjoys a popularity scarcely inferior to that of tobacco in this part of the world. The red colour imparted to the saliva and excrements of the betel-chewers is owing to the Areca nut, the astringency of which also tends to counteract the relaxation of bowels to which the climate so strongly predisposes. According to Ainslie, the fruit, when young and tender, is occasionally employed, in conjunction with other substances, in the form of decoction, in the constipation of dyspepsia. By the same author it is stated that a strong decoction of the nuts is used in dyeing.

It was formerly thought that Catechu was a product of this plant; and there is no doubt that in some parts of Hindostan, particularly in Mysore, an extract is prepared from its fruit, having the essential properties of Catechu, and used in the East for similar purposes. It is possible that some of this preparation may reach us among the varieties of catechu brought into the market; but by far the greater portion of this drug, and, perhaps, the only portion properly entitled to the name, is obtained from the *Acacia Catechu.* (See *Catechu.*) According to Heyne, two varieties of the extract of the Areca nut are known on the Coromandel Coast, one very astringent, called *cassu*, the other less astringent and somewhat sweetish, denominated *courry.* The former is obtained by evaporating the decoction of the fruit as immediately taken from the tree, and is of a blackish colour and usually mixed with impurities; the latter is the product of a second decoction and inspissation, is of a yellowish-brown colour, of a fine earthy fracture, and free from impurities, and is preferred by the betel-chewers. Ainslie gives an account of two extracts, which he says are obtained from the Areca nut, the one of a light brown colour, slightly bitter taste, and powerfully astringent, called *cuttacamboo* in the Tamul language; the other, almost black, hard, extremely bitter, and much less astringent than the former, and called *cash-cuttie.* Both are employed by the betel-chewers, but the former is greatly preferred. He states that they are taken to Hindostan from Pegu and Sumatra, but that they are also prepared of an inferior quality in Mysore, where they are used by the native practitioners, in bowel complaints, and as an external application to sphacelous ulcers. They are probably

identical with the extracts above mentioned by the names of *cassu* and *courry*.

The kernel of the fruit is occasionally brought to this country, and kept in the shops under the name of *Areca nut* or *betel nut*. It is of a roundish-conical shape, somewhat depressed, umbilicate at the base, rather larger than a chestnut, externally of a deep brown diversified with a fawn colour so as to present a reticular appearance, internally of a dark chestnut-brown colour with whitish veins, and whitish in the centre. It is very hard, of a feeble odour when broken, and of an astringent somewhat acrid taste. Besides a large proportion of tannin, it contains, according to M. Morin, gallic acid, a principle analogous to that found in leguminous plants, a red insoluble substance, a fixed oil, a volatile oil, lignin, and various saline ingredients. (*Journ. de Pharm.* 1822. p. 455.) In this country, it is used almost exclusively for the preparation of tooth-powder, for which purpose it is first reduced by heat to the state of charcoal. The superiority of this form of charcoal over that from other sources is ascribable to the extreme hardness of its particles.

Another species of Areca, the *A. Oleracea*, or *cabbage-tree* of the West Indies, is interesting on account of the use made of the leaf-bud upon the top of its stem. It is the highest and most beautiful of the American palms. The green summit of the trunk is formed by the sheathes of the leaves, within which is a white heart two or three inches in diameter, composed of the young leaves closely folded together. This is taken out by the inhabitants and eaten either raw or cooked, in the manner of the artichoke, which it is said to resemble in flavour. Geo. B. Wood.

ARENATION. (From *arena*, sand.) The envelopment of a part or the whole of the body in warm sand. It is one of the methods of applying dry heat to the cutaneous surface, to which it acts as an excitant, proportioned to the degree of caloric it possesses; and this excitation is transmitted to the subjacent parts. Sand has the inconveniences of being heavy and of parting too readily with caloric; which has led to the substitution of other articles, as bran, oats, &c. The ancients made frequent use of this therapeutic measure, which is certainly useful in some cases, and ought not to be so entirely neglected as it has been in modern times. Its *modus operandi* and *applicandi* will be fully noticed elsewhere. (See *Heat*, *Baths*, &c.)
I. H.

AREOLA. This is applied, 1. to the small interstices of the capillary net-work or between the fibres composing the organs (see *Cellular Tissue*, &c.): 2. to the coloured disc which surrounds the base of the nipple and of all inflammatory pustules of the skin. I. H.

AREOLAR TISSUE. (See *Angeial.*)

ARGEMONE. (*Mat. Med.* and *Botany.*)

Sex. Syst. Polyandria monogynia. *Nat. Ord.* Papaveraceæ.

Gen. Ch. *Calyx* three-leaved. *Petals* six. *Stigma* sessile, capitate, lobed. *Capsule* superior, with three to six angles, semivalvular, valves three to six. *Receptacle* filiform, marginal, persistent. *Seeds* globose, striated, and punctured. Nuttall.

A. Mexicana. Thorn poppy. *Mexicanische Argemone*, Germ. *Sp. Ch.* Leaves pinnatifid lobate, spinose; flowers axillary; capsules five-valved. Elliot. This plant is a native of Mexico, but has become naturalized in most parts of the world. It is an herbaceous annual, with alternate, amplexicaul spiny leaves, growing to the height of about two feet. The flowers, which are of a bright yellow, are succeeded by ovate spiny capsules, containing numerous, round, black seeds, having a somewhat pungent, warmish taste.

The whole plant abounds with a glutinous juice, which on exposure to the action of the air becomes of a bright yellow colour, closely resembling that of gamboge, and which, according to Long (*Hist. Jamaica.* III. 845.), has been found useful as a hydragogue in dropsies and jaundice In Java, this juice is used both internally and externally in cutaneous affections. Ainslie also states that it is considered by the Hindoos as a valuable remedy in ophthalmia, rubbed on the tarsus, or ever dropt into the eye. The seeds are employed in the West Indies as a substitute for ipecacuanha, in doses of two drachms infused in a pint of water. (Wright. *Med. Plants West Indies.*) They also act on the bowels, and are used as a purgative in many parts of South America. (Aublet *Hist. Guiane.*) The oil prepared from them has much reputation in India as an application to tinea capitis; it is, besides this, purgative.

The flowers are said by Decandolle (*Essai* 116.) to be used in Mexico as a narcotic.

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R. E. Griffith.

ARISTOLOCHIA. (*Botany* and *Mat. Med.*)

Gen. Ch. *Calyx* none. *Corolla* of one petal, ligulate, with a ventricose base. *Capsule* six-celled, many-seeded, inferior. NUTTALL.

This genus of plants consists of about fifty species, most of which are peculiar to warm climates; they are, in general, herbaceous or shrubby, with erect or twining stems, and alternate, cordate and entire leaves; the flowers are usually axillary and recurved. Most if not all the species are possessed of medicinal properties, and have been regarded as infallible alexiterics. It is a remarkable fact that a firm belief in the efficacy of these plants as antidotes against the poison of snakes, should exist in all parts of the world, and among nations who could have had no communication with each other; and yet there is every reason to believe that they possess no such powers.

The most active part is the root; this, in most of the species, is aromatic and stimulating; in some, however, it is extremely acrid, and requires great caution in its administration. Only one of these plants is recognized by the United States Pharmacopœia, as officinal.

A. serpentaria. Virginia Snakeroot. *Serpentaire de Virginie*, Fr.; *Virginische Schlangenwurzel*, Germ. *Sp. Ch.* Leaves cordate, oblong, acuminate; stem flexuous; peduncles radical; lip of the corolla lanceolate. WILLDENOW. This well-known plant is found in most parts of the United States, growing in shady woods, especially on hill-sides; it is less common in alluvial and limestone regions. The root is perennial, brown, and extremely fibrous; the fibres are long, slender, and of a yellowish colour when fresh. The stems, several of which spring from the same root, are slender, flexuous, jointed, generally less than a foot in height, furnished with from three to seven leaves, and bearing one to three flowers. The leaves are alternate and petiolate, oblong, entire, acuminate, cordate at base. The flowers grow close to the ground, on curved, jointed peduncles, furnished with small scales; they are of a dull brownish-purple colour, and consist of a long contorted tube, enlarged at each extremity, the border expanded into a broad irregular margin, bilabiate, the upper lip notched, the lower entire. The capsule is obovate, six-angled, six-celled, containing numerous rather flat, small seeds.

This plant, however, requires a thorough investigation, as it appears highly probable that several species are included under the title of *A. serpentaria*, having very analogous leaves and roots, but presenting striking dissimilarities in their flowers. Be this as it may, there is no doubt that the Serpentaria of the shops is furnished by more than one species; these are the *A. serpentaria*, *A. hirsuta* (MUHL), and *A. sagittata* (MUHL). BARTON (WM. P. C.) says that on an examination of specimens of these plants in the Muhlenberg Herbarium (now in possession of the American Philosophical Society), he found that no difference was perceptible in their sensible properties; and Mr. D. B. SMITH states that in examining several parcels of the snakeroot of the shops, he was able to distinguish three well characterized forms of the leaves; these, he goes on to say, appeared to answer the descriptions of the species above alluded to; there was no perceptible difference in the smell or taste of the roots. Hence it would seem that in a pharmaceutical point of view, this confusion of species is of no consequence, and affords another proof that the plan adopted by the authors of the last edition of the United States Pharmacopœia, of adopting a pharmaceutical name for most of the vegetable remedies, independent of their botanical designation, is a wise one. (See *Serpentaria.*)

Some other species of Aristolochia are recognized by the foreign Pharmacopœias. These are:—

A. clematitis. *Aristoloche vulgaire*, Fr.; *Waldrebenhohlwurzel*, Germ.

This is a perennial plant peculiar to the temperate and warm regions of Europe, growing in vineyards, on the margins of streams, &c. It at one time enjoyed a high reputation as a febrifuge and emmenagogue, but at present is but little used. The part employed is the root, which is long, cylindrical, simple, fibrous, contorted, of the thickness of the little finger, of a reddish or brownish-yellow on the exterior, and white or yellowish within. It has a weak and slightly disagreeable odour. Its taste is acrid, bitter and astringent. From the experiments of ORFILA it appears that it should be given in moderate doses, as he found that it caused death, by a narcotic action on the nervous system. This root formed one of the ingredients of the celebrated Portland powder, once considered as a specific in gout.

A. pistolochia. *Aristoloche crénelée*, Fr.; *Netzblatthohlwurzel*, Germ.

A perennial plant indigenous to southern Europe and Switzerland. The part employed is the root, which is composed

of numerous slender fibres, about six inches in length, of a yellowish-gray colour. It has an aromatic and agreeable odour, and an acrid bitter taste. It partakes of the medical properties of its congeners, and forms an ingredient in the theriac.

A. longa. *Aristoloche longue*, Fr.; *Langhohlwurzel*, Germ.

This species, which is found in many parts of Europe, is much employed in medicine by French and German practitioners as an emmenagogue and anti-arthritic, and forms part of a great number of officinal preparations. It is a tolerably energetic stimulant in doses of two drachms. Cadogan (*Treat. on the gout*) says that he has seen it produce unpleasant consequences when incautiously given, before the reduction of arterial excitement. The part used is the root, which is sometimes a foot long and as thick as the finger; it is wrinkled, of a bright brown externally, and yellowish within. Its odour is very weak; its taste acrid and nauseous. According to M. Lassaigne (*Journ. de Pharm.*) it contains a great quantity of ulmine.

A. rotunda. *Aristoloche ronde*, Fr.; *Rundhohlwurzel*, Germ.

This is a native of the southern parts of Europe, and is identical in its properties with the last mentioned species. The root is almost globular, heavy, compact, tuberous, brownish and somewhat wrinkled externally, and yellowish within. It has a strong disagreeable smell when fresh, but becomes almost inodorous when dry. The taste of the fresh root is acrid and bitter, but is feeble and nauseous in the dry state.

A. trilobata. *Aristoloche trilobée*, Fr.; *Dreylapphohlwurz*, Germ.

A perennial plant, found in South America and some of the West India islands. This species has the odour of the *Prunus padus*, and is said to be superior in medical virtues to the Serpentaria. Linnæus speaks of it in his Materia Medica, as an excellent alexiteric in the bite of the viper. The part employed is the twigs. These, as found in the shops, are long, angular, grooved, brittle, of a brown colour, and about as thick as a straw. They have a strong smell of camphor, and a permanent, very bitter, aromatic but disagreeable taste. The dose is from five to twenty grains.

Besides those species which are officinal, there are many others spoken of by recent writers, and which require notice.

A. bilobata, a native of Brazil and the West Indies, is used as an emmenagogue, and its root is introduced into the vagina, to induce the expulsion of the fœtus, when dead. (Descourtils. *Fl. Méd. des Antill.* II. 5.)

A. bracteata. A native of India. An infusion of the dried leaves is given by the Hindoo practitioners as an anthelmintic, in doses of ℨii. twice daily; and when fresh, bruised and mixed with castor oil, they are used as an external application in obstinate psora. (Ainslie. *Mat. Ind.* II. 5.)

A. cordiflora. This species bears flowers of an immense size. It is a native of Colombia. The root is considered as an antidote against the bites of venomous snakes. (Humboldt. *Nova Gen.* II. 149.)

A. fœtida. A native of Mexico. A decoction of the root is much used as a wash in old ulcers. (*Nova Gen.* II. 147.)

A. fragrantissima. A native of Peru, where it is called *Bejuco de la estrella*. The part employed in medicine is the bark. This is compact, of an ash-gray colour externally, and reddish within; of a camphorated odour, and a pungent and aromatic taste. It is much used in fevers, in scruple to half drachm doses. It is also employed as an emmenagogue and alexiteric. (Alibert. *Mat. Med.* III. 71.)

A. indica. A native of India. This is highly esteemed by the Hindoos as an emmenagogue and anti-arthritic. (Ainslie. *Mat. Ind.* II. 5.) Thunberg says that a tincture of the root is given in Ceylon as a stomachic and carminative.

A. odoratissima. This species is found in the West Indies. Ainslie states on the authority of Lunan (*Hort. Jamaic.*) that it is a most valuable alexipharmic, and tonic. Lamarck (*Encyclop. Method.*) says that the juice has proved very efficacious as a febrifuge.

A. sempervirens. A native of Arabia, where, according to Forskal, the leaves are employed in wounds of the tendons and bites of snakes. In the latter case, a decoction of them with milk must also be taken for some time. (*Flora Egypt-arab.* 157.)

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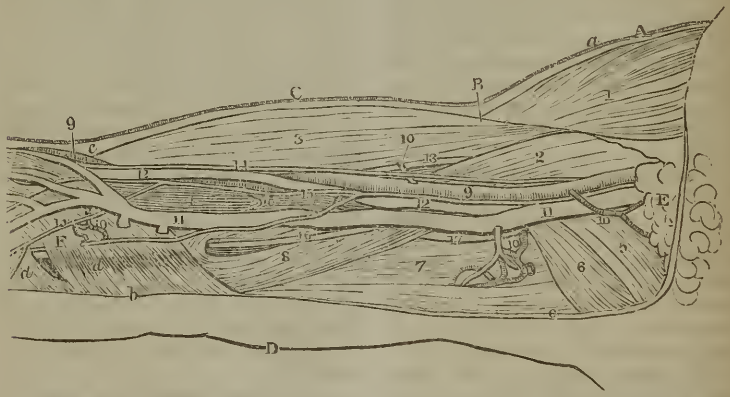
ARM. (*Brachial region.*) In common language, the term arm is employed to designate the whole of the upper extremity; but by the anatomist it is restricted to that portion of the member comprised between the axilla and the elbow,—the other portions being denominated fore-arm and hand (q. v.). Our observations will apply to the arm considered in the anatomical sense.

Art. I. Surgical Anatomy. The length and thickness of the arm vary in different individuals, and the latter is greatly influenced by fortuitous circumstances. In general, the humerus is about one-fifth longer than the radius; but under various modifications of development, these relations may be materially changed. An accidental interruption of the regular evolution of the one or the other bone, may give rise to a preponderance of length and thickness in the other. The entire humerus may, indeed, from this cause, be wholly absent,—or the same influence may occasion a total absence or imperfect development of either the radius or ulna, or both,—the humerus being perfectly formed. In the example of a Moor, whose body was brought to our dissecting-room a few years ago, the bones of both fore-arms were not more than six inches in length, although the humerus was of its natural size. Velpeau refers to a case, in which the arm was shorter by one-fourth than the fore-arm. He also remarks, that he had seen two adults in whom the arm, on one side, had ceased to grow at the age of ten years, while the other attained its ordinary size. (*Dict. de Méd.* 2d edit. Art. *Bras.*) In the one case, the member was atrophied and partially paralyzed; in the other, the fore-arm had been amputated below the elbow. He infers that the arrest of development was owing to an obliteration of the artery of the arm, inasmuch as, in neither instance, could its pulsations be perceived.

Examined in its totality, the arm may be compared to a cylinder, slightly compressed upon its sides, having several elevations and depressions upon its surface. The elevations are occasioned by the full and prominent bellies of the muscles; the depressions mark the spaces between them. Hence, both are more conspicuous in stout robust males, in whom the muscular system is strongly developed, than in females, or those who are feeble and emaciated.



A, Deltoid. B, Insertion of Deltoid. C, Biceps. D, Triceps. E, Axilla. F, Situation of Inner Condyle of Humerus.
a, Skin on outer side of the Arm. *b*, Skin on inner side of the Arm. *c*, Cellular and Adipose Tissue. *d*, Fascia.
1, Pectoralis Major. 2, Coraco-brachialis. 3, Biceps. 4, Brachialis Internus. 5, Latissimus Dorsi. 6, Teres Major. 7, Triceps, long head. 8, do. short head. 9, Brachial Artery. 10, External and Internal Collateral, Nutritious, and Anastomoticus Major Arteries. 11, Basilic Vein. 12, Deep-seated Vein. 13, External Cutaneous Nerve. 14, Median Nerve. 15, Internal Cutaneous Nerves. 16, Ulnar Nerve. 17, Radial Nerve.

The *elevations* are—first, one occupying the upper part of the arm, formed by the deltoid muscle (A). It is broad and expanded above, where it forms the rounded prominence called the point of the shoulder. It descends about one-third down the arm, and terminates in a narrow point below, where it marks the attachment of the deltoid to the shaft of the humerus (B). When the arm is elevated, this prominence presents an anterior and a posterior border, both of which com

mence at its lower termination, and gradually diverge,—the first ranging obliquely inwards, in front of the shoulder, towards the clavicle; the second, obliquely backwards and inwards, along the posterior boundary of the shoulder. Occupying the anterior aspect of the arm, and ranging in a perpendicular direction from the axilla to the bend of the elbow, there is a second prominence, occasioned by the biceps muscle (C). It is fullest at about the middle of the arm, and tapers towards its two extremities, the upper of which is formed in part by the coraco-brachialis muscle. Posteriorly, the fleshy mass of the triceps (D) forms a still larger prominence, which extends perpendicularly from the lower part of the neck of the scapula, to the olecranon process of the ulna. The arm likewise presents, at the elbow, an internal and an external lateral projection of limited extent, formed by the corresponding ridges of the humerus which lead to the condyles.

On the inner and outer faces of the arm, on each side of the bicipital prominence, we have an elongated furrow or depression, ranging parallel with the axis of the arm. The *internal bicipital furrow* commences in the axilla (E), and extends to the inner condyle of the humerus (F), or rather to the bend of the arm. It is bounded, in front, at its upper part, by the coraco-brachialis—throughout the lower half of the arm, by the biceps; posteriorly, by the triceps, except near its termination, where its boundary is formed by the pronator radii teres. It is traversed by the brachial artery and veins, the basilic vein, the median and ulnar nerves, and numerous lymphatics. It is in this furrow that the artery has to be exposed when it becomes necessary to secure it by a ligature; and it is owing to the presence of these vessels, that when this part of the arm is affected with inflammation, uneven indurated chords can be felt, running upwards to the axilla. The *external bicipital furrow* occupies the opposite face of the arm, and extends from the axilla, where it commences immediately behind the attachment of the pectoralis major, to the elbow. It is bounded in front by the biceps, and posteriorly by the triceps, except in the vicinity of the elbow, where the long supinator intervenes between the furrow and the triceps, and forms its external boundary. At the bend of the arm, it unites with the internal furrow at an acute angle, the space between them being occupied by the tendon of the biceps. This furrow is traversed for some distance

by the cephalic vein, and from the middle of the member downwards, is occupied by the radial nerve, which, after having twined around the posterior part of the humerus to reach the anterior radial face of the arm, follows it to the bend of the elbow. Following the anterior and posterior margins of the deltoid, there are two other furrows, which, as they advance upwards, gradually recede from each other, the one following the line of separation between the deltoid and pectoralis major,—the other advancing backwards, to terminate upon the dorsum of the scapula. Where these furrows commence upon the arm, consequently where the deltoid is attached to the humerus, no muscle, or important vessel or nerve, intervenes between the skin and the bone, which being merely separated by cellular tissue, this point has been selected as the most eligible portion of the arm, for the insertion of a seton, the establishment of an issue, and, by many, for vaccination.

The *skin* upon the outer (*a*) and inner (*b*) sides of the arm differs in some important particulars. On the whole of the inner side of the member it is remarkably thin, soft and vascular, and is less firmly united with the structures beneath, than at any other point. Hence it glides with greater facility, takes on inflammation more readily, and is more prone to become affected with erysipelas. It is likewise more abundantly supplied with lymphatic vessels, which circumstance, together with its great tenuity, increases its absorbent faculties. When the lymphatics become acutely inflamed, the great thinness of the skin upon this portion of the member, shows these vessels ascending towards the axilla, in form of delicate red lines. On the other portions of the member, the skin is thicker, more compact in its structure, and more abundantly supplied with sebaceous follicles. It is, therefore, more readily affected with eruptive diseases, and also with erysipelatous inflammation; but is not so liable to be attacked with that of a phlegmonoid character, as that of the inner part of the member. The skin upon the whole circumference of the arm possesses great mobility, so that in amputations, and other operations, no difficulty is experienced in preserving sufficient flap; yet from this very circumstance, great caution is requisite, not to save too much skin, as it will be very apt to become turned inwards upon the wound, and prevent union by the first intention.

The *cellular* and *adipose* panicle (*c*)

which intervenes between the skin and the muscles, varies in thickness, as well as in texture, upon different portions of the arm. Along the internal bicipital furrow it is abundant, and its meshes are remarkably loose. This character renders it more prone than the cellular tissue of other parts of the arm, to become affected with phlegmonoid erysipelas, which frequently diffuses itself along the whole length of the member, giving rise to an extensive slough, by which the muscles and blood-vessels are not unfrequently laid completely bare. From the same cause, purulent deposits formed in this situation, are seldom so narrowly circumscribed, as in other portions of the member; and very often the matter diffuses itself extensively through the meshes of the tissue, and involves the whole inner part of the arm in extensive suppuration. When, moreover, the artery is wounded, the blood may be driven extensively through this tissue, and may occasion either a diffused aneurism, or an ecchymosis of great extent. Posteriorly and externally, the tissue is more dense and resistant; hence, deposits of pus or blood in these situations are generally circumscribed within narrower limits, and are less apt to become extensively diffused. This disposition renders the tissue less prone to become involved in extensive erysipelatous sloughing than that which occupies the inner surface of the arm; at least, when this form of inflammation attacks these portions of the member, it does not spread so readily, and is consequently confined to smaller limits.

The *fascia* of the arm (*d*), though at some points consisting of little more than a simple layer of cellular tissue, deserves to be examined, since it has important relations with the muscles and blood-vessels, as well as with the articulation of the shoulder joint. It may be considered as a kind of sheath, surrounding all the muscles and vessels, and divided into a number of lesser sheaths or partitions, there being one for each of the parts contained within, yet all intimately associated with each other. The first of these secondary sheaths is that which incloses the biceps muscle. If this sheath be laid open in front, and in the direction of the length of the muscle, by dissecting it outwards, it will be found to pass off from the corresponding edge of the biceps, to become attached to the external condyle and the outer edge of the humerus, from the elbow upwards, as high as the attachment of the deltoid muscle. Above that point it is reflected over the deltoid and pectoralis major, to form a similar covering for them. Cutting up its attachment from the outer line of the bone, it can be traced backwards upon the triceps, where it is continuous with the fascia of the posterior face of the arm. From the inner edge of the biceps it passes off, in the inferior half of the arm, upon the arteries, veins and nerves, and divides into a number of partitions, which, passing in their interstices, form a sheath for each of them. It then attaches itself to the whole extent of the inner line of the bone, from the condyle to the axilla. In the upper half of the arm, however, the fascia, instead of passing directly from the biceps over the vessels and nerves, is first distributed over the surface of the brachialis internus, beyond the edge of which, it pursues the same arrangement as below. In the axilla, it loses itself in a bed of cellular tissue, containing numerous lymphatic glands, which, by extending upwards beneath the pectoralis minor muscle, and behind the clavicle, serves to associate the fascia of the arm with that of the thorax and neck. From the point at which the fascia of the arm is reflected over the short head of the biceps and the coraco-brachialis, it can be traced upwards along those muscles, until it loses itself in the capsular ligament of the shoulder joint on the one hand, and attaches itself, on the other, to the coracoid process, and the lunated ligament by which it is united with the anterior edge of the outer extremity of the clavicle. (*Anatomical Investigations*, by J. D. Godman, M. D. Philada. 1824.) This latter portion, spreading itself over the surface of the pectoralis minor muscle, forms the sheet of fascia which is perforated by the cephalic vein, before it unites with the axillary. A similar sheath invests the brachialis internus, and attaches itself in like manner along the inner and outer margins of the humerus.

On the posterior part of the arm, the arrangement of the fascia is more simple. From the inner and outer margins of the humerus, to which it is attached from the condyles upwards, it glides over the surface of the triceps muscle, forming for it a sheath, simple at its lower part, but divided above to adapt itself to the several heads of the muscle. One of these divisions, following the long head of the triceps, becomes attached to the inferior costa of the scapula, and continues with the aponeurosis which invests the teres minor and infraspinatus muscles.

The *muscles* of the arm exercise great

influence on operations practised upon it, as well as on many of the accidents to which it is exposed. Those which arise from the scapula, and attach themselves to the head of the humerus, need not be described, as they are more particularly concerned in the mechanism of the shoulder joint; but the deltoid (A), pectoralis major (1), latissimus dorsi (5), and teres major (6), confined to the upper third of the member; the biceps (3) and triceps (7, 8), occupying its whole length; and the coraco-brachialis (2) and brachialis internus (4),—the first limited to the upper half,—the second to the lower—deserve to be carefully noted. The deltoid, from the manner in which it acts upon the humerus, would naturally tend, when that bone is fractured below the point of its attachment, to elevate the upper fragment, so as to allow the lower to glide beneath it, were it not that its action is more than counterbalanced, under such circumstances, by the pectoralis major, latissimus dorsi, and teres major, which draw the broken bone towards the side of the body. This being the case, the lower fragment overlaps the upper upon its outer side, in which direction it is drawn by the biceps and other long muscles. But should the bone be broken through its surgical neck, the same forces will give rise to a different displacement. The pectoralis major and latissimus dorsi will then draw the lower fragment towards the side of the body, while the upper, somewhat elevated by the muscles inserted into the head of the bone, will overlap it. The biceps, extending as it does the whole length of the arm, without forming any attachment with the humerus, exercises considerable influence in displacing the bone when it becomes fractured,—a displacement which could not be rendered considerable by the sole action of the triceps and brachialis internus, inasmuch as the attachment of those muscles to all the lower part of the bone, would naturally tend to resist any great overlapping of the fragments. These same characters in the relations of the long muscles of the arm, are moreover important in connexion with the operation of amputation. The one being free, and the others attached to the whole length of the bone, they will retract unequally when divided,—the biceps undergoing this change to a much greater extent than the others. The consequence of this will be an irregular stump, unless the precaution be observed, to divide the biceps first, and after it has retracted to the full extent, to divide the others on a level with it. This course should be adopted, whether the operation be performed by the circular incision or double flap, since the disposition of the structures of the arm is such, that the flaps can scarcely be formed, except from the anterior and posterior part of the member; and as the biceps would retract much more than the triceps, the flaps would be of unequal length. (See *Arm, Amputation of.*) The muscles near the shoulder joint likewise present an arrangement which disposes them somewhat, when divided in amputation by the circular incision, to retract unequally, or at least in such a manner, as to impart some inequality to the stump. This is more particularly true of the pectoralis major, latissimus dorsi, teres major, and the long head of the triceps (7). Hence, many surgeons have condemned the performance of amputation at that point, except by the flap; and some have even contended, that when it becomes necessary to amputate the arm so high up, the operation should be practised at the shoulder joint. There is, however, no valid reason for the adoption of the latter procedure.

The arm is traversed along the whole extent of its inner side, from the axilla to the elbow joint, by the brachial *artery* (9) and its accompanying *veins*, all of which are lodged in the bicipital furrow or depression of the member. As the vessel advances from above downwards, its course is somewhat spiral, inasmuch as where it approaches the elbow, it gradually winds forwards to reach the central portion of the bend of the fore-arm. Throughout its entire course, it reposes so closely upon the bone, that it can be easily commanded by pressure; and in some cases of fracture, it may be lacerated by the sharp fragments of bone. In the upper third of the arm, it courses along the inner margin of the coraco-brachialis (2); but, from the point at which that muscle is attached to the humerus, to the elbow joint, it is placed immediately on the inner side of the biceps (3). In its whole extent, it is enveloped in a sheath furnished by the fascia of the arm, and is merely covered by the skin, cellular tissue, and fascia. It is generally accompanied by two corresponding veins, between which it is placed; and in the upper part of the arm, the median nerve (14) courses along its outer side, between it and the coraco-brachialis muscle—sometimes immediately in front; but lower down, the nerve crosses obliquely in front of the artery, and gets on the inner side of it. High up, the ulnar (16), radial (17), and inter-

nal cutaneous (15) nerves are likewise placed upon its inner side, and in such intimate relationship, as to render it more difficult to isolate the artery in that situation than lower down, where the nerves are further removed, in consequence of the manner they gradually recede from the vessel, to reach the internal and posterior parts of the arm. The artery may, nevertheless, be easily exposed at any point of its transit, by conducting an incision along the inner margin of the coraco-brachialis, in the upper third of the arm, and the border of the biceps in the inferior two-thirds. Or, if the outline of these muscles should not be well defined, the incision may be made upon the course of an imaginary line drawn from near the middle of the axilla, to the middle of the bend of the arm. High up, the median nerve (14) must be turned outwards to expose the vessel; near the middle of the arm, it crosses the artery obliquely—generally in front, but sometimes behind, and care must be taken not to include it in the ligature. From this point to the bend of the arm, it is situated on the inner side, and must be carried towards the internal part of the arm, during the application of the ligature.

The other arteries of the arm are small, and merely consist of branches of the brachial. They are the external and internal collateral (10), the nutritious, and the anastomoticus major (10). The first comes off high up, and twines round the posterior part of the humerus to get to the radial side of the fore-arm, and anastomose with the external recurrent. The internal collateral is smaller, and takes its course towards the internal condyle, to anastomose with the internal recurrents. Both these vessels, as well as the anastomoticus major, are only important in establishing a free collateral circulation, which serves to compensate for the obliteration of the main trunk. Hence, after the operation for aneurism, they become so much dilated, as to be capable of transmitting an adequate quantity of blood to the structures of the fore-arm and hand, to maintain the integrity of their vitality. These vessels may, moreover, in consequence of their proximity to the bone, become pricked or lacerated by spiculæ when the humerus is fractured, and thus give rise to considerable extravasation or ecchymosis,—an accident which is peculiarly liable to happen to the nutritious branch, when the fracture takes place in the vicinity of the point at which it penetrates the bone.

The brachial artery presents many varieties in its division and the order of its distribution. These, however, will be described under the head of *Arteries, Special Anatomy*.

The deep-seated *veins* of the arm (12), generally two in number, though sometimes there is only one, follow the course of the artery, which is placed between, and a little behind, them. In some instances, transverse branches pass from the one to the other vein, in front of the artery, which are sometimes divided in cutting down to secure the vessel, and bleed so freely as to embarrass the operation. The superficial veins, the basilic (11) and cephalic, though not covered by any important structures, are contained within a sheath or duplicature of the fascia of the arm. The first occupies the inner side of the arm, but is so far removed from the artery, that it cannot be in the way of an operation instituted for the purpose of securing that vessel. It sometimes continues to the axilla as a single branch, but frequently unites with the deep-seated veins in the upper third of the arm. The cephalic mounts from the bend of the arm along the outer side of the member, until it reaches its upper third,—then inclines forward, and runs in the space between the deltoid and pectoralis major, until it reaches the axillary vein below the clavicle, where it unites with that vessel. It is more superficial than the basilic, and can be easily discovered beneath the skin. The ancients were in the practice of drawing blood from it, under the impression, that a direct derivation was thus made from the head, from which circumstance the vein received the name which is still applied to it. Both superficial veins sometimes become affected with phlebitis, under which circumstance, they form two solid rounded chords, tender and painful to the touch, the course of which is marked with more or less redness of the superjacent skin. They seldom become varicose to any great extent; yet VELPEAU has remarked, that in two cases, he found them so much affected in this way, that at times the members seemed to be transformed into erectile tissue, and the veins were covered by irregular elevations throughout their whole extent. (*Dict. de Méd.* 2d edit. V. 1833.)

The *lymphatics* are likewise superficial and deep-seated. The first are situated between the skin and fascia, and when inflamed, their course is accurately defined by one or more irregular indurated chords, the course of which is frequently repre-

sented by a streaked redness, and by tenderness of the skin. This condition is not unfrequently observed after the operation of venesection, when much inflammation supervenes, as well as in those cases in which abscesses and other diseases occupy some part of the member lower down.

The *integuments* of the upper third of the arm receive a number of nervous filaments from the intercostal nerves, and the whole length of the region is traversed by the cutaneous and deep-seated nerves. The first, comprising the internal and external cutaneous, and a small branch called cutaneous of Wrisberg, are destined for the integuments of the arm and fore-arm. The internal cutaneous (15) descends along the inner side of the arm towards the internal condyle (F);—the external (13) traverses the coraco-brachialis muscle (2), to which and the biceps it sends filaments, and descends to the corresponding portion of the opposite side of the arm. The cutaneous of Wrisberg is spent upon the integuments upon the anterior and internal part of the member. Most of their filaments are distributed superficially, and some of them occasionally become the seat of small subcutaneous nervous tumours, which are exceedingly painful. The course of the median nerve (19), and its intimate relations with the brachial artery, have been already indicated. The ulnar nerve (16), as it descends, gradually inclines backwards, and recedes from the artery, to pass behind the internal condyle, and between it and the olecranon; while the radial (17) twines round the posterior surface of the humerus, between two of the heads of the triceps, to reach the radial side of the fore-arm. In its course, it sends numerous filaments to the neighbouring muscles. From the situation of all these nerves, they are necessarily much exposed to injuries, which are always attended with a paralysis of the muscles to which the injured nerve is distributed. Their proximity to the bone, moreover, exposes them, in a great degree, to lacerations and contusions, from the sharp projections or spiculæ of the fractured humerus, and occasionally tetanus has been thus induced. The same intimate relations sometimes occasion one or more of them to become embedded in the mass of new bone which forms around the point of fracture. An example of this kind, in which the radial nerve became thus encased, has been reported by Manec. (*Bibliothèque Méd.* I. 441. 1828. Velpeau. *Loc. Cit.*)

As regards the *humerus*, much need not be said here. Slender throughout the whole of its shaft, slightly flexed upon itself, and besides greatly exposed in consequence of the nature of its relations, to violence from various sources, it is remarkably liable to be fractured. And it is somewhat curious, that of all the cylindrical bones, it is one of those most liable to become affected with necrosis, when seriously injured, as from gun-shot wounds, and other accidents of a similar character. Sometimes nearly the whole extent of the shaft is thus destroyed and converted into a sequestrum,—the strong and dense periosteum which surrounds it, throwing out a thick layer of callus, which forms for the dead bone a firm osseous casement.

But from the few muscles which surround it, and especially from the absence of any very large vessel upon the posterior and external parts of the member, it will always be easy to make an incision through the soft parts, and after opening the incasement formed by the new bony deposit, to extract the sequestrum. Indeed, should such a procedure become necessary, the entire bone might probably be removed in the same manner. (See *Resection.*) It should be remarked, moreover, that individuals who have lost a considerable portion of the humerus, are still capable of using the member with great advantage. Jules Cloquet has reported an interesting case illustrative of the truth of this assertion. An individual who had lost the two upper thirds of the bone, was still capable of using the arm with considerable success. Similar cases have been observed by Yvan and others. (*Dict. de Méd.* V. 580.) The arm likewise often becomes the seat of false articulations, consequent upon fractures improperly adjusted or inadequately confined. But it is fortunate, that the arrangement of the member is such, as to render it favourable for the institution of those procedures which are necessary for the radical cure of such accidents. E. Geddings.

Art. II. Surgical Pathology. The arm, as a region, is subject to a great variety of lesions, but most of its diseases and accidents derive little importance from their particular location, and the discussion of them is therefore referred to the appropriate general articles, or to those which treat on the several tissues. Injuries and changes of structure seated in the neighbourhood of the articulations of the os humeri are attended with more peculiar circumstances, and demand notice; but these, together with the surgical anatomy of the parts involved, will be treated

under the heads of *Shoulder* and *Elbow.* It only remains for us to notice, in this place, 1. fractures, 2. amputation, 3. resection of the body of the humerus, by which we mean, that portion of the shaft of the bone which lies between the upper part of the insertion of the pectoralis major and latissimus dorsi muscles, and the lower part of the origin of the brachialis and the third head of the triceps, and 4. aneurism and ligature of the brachial artery.

§ 1. *Fractures. The frequency* of these accidents is not so great as the exposed situation of the arm would lead us to expect. The lightness of the member and the facility of its movements, together with the absence of the pressure of superincumbent parts, more than compensate for the extent of its motion, and its constant collisions with surrounding bodies, and render it less liable to fracture than the inferior extremity. Some surgeons are of a different opinion, but in the practice of our public institutions, fractures of the leg and thigh, as well as the clavicle, are more frequently noticed than those of the arm.

The varieties in direction, extent and location are numerous. The bending or partial fracture of the arm, is indeed rare; we have seen but two cases of this character, occurring in young children. In one of these, the bone was curved very obviously, but not to any great extent. It was restored to its proper position without completing the fracture. In the other case, the deformity was more angular and much more considerable. The angle was just below the insertion of the deltoid, and the fracture was completed in the attempt to reduce the limb. As often happens in such cases, a slight incurable deformity was produced by the curvature of the extremities of the fragments. (See *Bones, pathology of.*)

1. *Longitudinal fractures* sometimes occur, but they are generally connected with the elbow joint, (q. v.), and may be therefore regarded as extensions of fracture of the condyles. We have never met with any record of longitudinal fracture of the body of the bone not extending to the joint, and it may be proper to notice a case which came under our care in the Pennsylvania Hospital, in the year 1823. A young carpenter who was standing near a new building, with his left hand on the round of a ladder, received a blow upon the arm from a sharp spade which fell from the summit of the wall. The edge of the spade made an incision for nearly its whole length near the outer margin of the biceps muscle, wounding also the lower part of the deltoid; and the corner of the blade striking the os humeri about three inches above the external condyle, separated a fragment, four inches or more in length, and in thickness equal to about one-third of the diameter of the shaft, from the outer and back part of the body of the bone. The extent of the wound was such that the fragment could be seen and felt. It was completely detached and moveable; but as its connexions with the surrounding soft parts were but little disturbed, and the periosteum was not abraded, it was suffered to remain *in situ*; adhesive strips to the wound were employed, a roller was applied to the whole limb, and the arm was confined on an angular splint. The wound healed by the first intention, and the fragment was reunited without accident or deformity.

2. *Oblique* and *transverse fractures* of the arm are common, though we rarely see any very great degree of obliquity in these accidents. It is by no means necessary to distinguish the peculiar direction of the fracture in most cases, for reasons which will be given when we consider the character and causes of the displacement: indeed, much more mischief than benefit results from hypercritical researches on this point. If the obliquity is very considerable, some peculiar precautions are required to secure the accurate coaptation of the fragments, and to prevent the occurrence of a pseud-arthrosis; but in such cases, the obliquity of the fracture is detected, on the most superficial examination.

Interlocking of the fragments from great irregularity in the direction of the fracture, is sometimes noticed, and may render complete reduction difficult, or perhaps impossible; but the deformity resulting from this cause is unimportant, being confined to a slight displacement in the direction of the diameter of the bone, which is scarcely, if at all, perceptible after the cure.

The causes of fracture of the body of the humerus, are generally such as act directly on the part. The absence of all considerable curvatures in the bone, renders it little subject to injury from forces acting through the medium of the fore-arm or the trunk; in this respect, it is strongly distinguished from the os femoris.

When the forces just mentioned do produce fracture of the humerus, it takes place almost invariably about the condyles; for the position of the head of the bone is such, that the clavicle or some of the processes of the scapula give way be-

fore the neck or body of the humerus is endangered.

Spontaneous fracture of the humerus from fragilitas ossium, cancer, &c., will be considered in the general article on *Fractures*. But it is possible for the arm to be broken by muscular contraction alone. An example of this last accident is recorded by Dr. KIRKBRIDE, in the *American Journ. Med. Sc.* XVI. 33.; another was presented some years since in the Pennsylvania Hospital; and a third occurred in the clinic of Mr. GUTHRIE, at Westminster Hospital, during the last year. (*Lond. Med. and Surg. Journ.* VII. 446. 1835.; also, *Amer. Journ. Med. Sc.* XVI.) In the two first cases there is every reason to believe that the bones were healthy. All the cases, but the last, recovered without accident, in the usual time, and all resulted from throwing very small substances.

Character and causes of displacement. In fractures of the arm, the weight of the limb exerts considerable influence over the displacement of the fragments. It acts as a perpetual counter-extending force, while the patient sits or stands erect, and thus resists the tendency to longitudinal derangement; while it not unfrequently becomes a cause of various angular deformities, during changes in the position of the patient. The muscles which lie lengthwise around the bone, are not very powerful in their habitual contraction, and when weakened, even by slight contusions, are sometimes unable to support the head of the bone in contact with the surface of the glenoid cavity. In consequence of this laxity, there is little tendency to shortening of the limb from muscular contraction, even when the apposition of the extremities of the fragments is completely destroyed by the accident. Nor is it difficult to prevent the recurrence of shortening after the reduction, except in the rare cases of great obliquity in the fracture, for the absence of considerable curvatures in the bone, and the facility with which the general direction of the limb is preserved during the treatment, secure the constant apposition of the fractured extremities. These remarks apply with most force to fractures occurring at or below the insertion of the deltoid muscle. In all this portion of the body of the bone, the muscles, when not extensively injured, act the part of imperfect splints, and limit more or less the derangement which would otherwise arise from the action of the deltoid and coraco-brachialis muscles.

Lateral displacements may occur in any direction, but are seldom so extensive as to destroy entirely the apposition of the extremities of the fragments; and angular derangements equally various are very frequently observed. The characters of this kind of displacement, whether caused by the weight of the limb and the motions of the patient, or by the original forces producing the fracture, are so very uncertain that they cannot be reduced to regular rules; but this circumstance is less regretted, because it neither obscures the diagnosis nor modifies the treatment. Lateral displacement from muscular action is somewhat more important, as it has a tendency to return after reduction, and may require, in certain cases, a slight modification of the apparatus.

As the nature of this species of displacement has been already mentioned in the article on the Surgical Anatomy of the arm, p. 247, we shall add but a few remarks to those therein contained. When the fracture is seated within the attachments of the deltoid, this muscle acts upon both fragments at once, producing a tendency to angular deformity, outward, or outward and forward, which is controllable with great ease; but when it passes through the attachments of the teres major, latissimus dorsi, and pectoralis major, there is a much stronger disposition to angular deformity inward, and one which is far less easily managed, because the superior fragment is short, superficial, and covered by parts intolerant of much pressure. Fracture in this situation is, however, comparatively rare. In neither of the cases just mentioned do we see that partial or complete separation of the fragments which occurs when the bone is fractured immediately below the insertions of the muscles.

The last species of displacement demanding attention, is that produced by the rotation of the lower upon the upper fragment, consequent upon changes of position in the fore-arm. This displacement should never be neglected during the treatment, or considerable embarrassments to the motions of the limb may result from the reunion of the fragments in their malposition. The extent of the rotation can be readily ascertained at all times, by observing the relative location of the external condyle and the point of the acromion process of the scapula.

The *diagnosis* of fracture of the body of the humerus is extremely clear. It may be generally detected at a glance, unless when situated above the insertion of the deltoid. The fore-arm hangs feebly by the side of the patient; all attempts at voluntary flexion or extension, are painful, and extensive motions of this charac-

ter are commonly impossible; unless the fracture is nearly transverse, or there is interlocking of the fragments. Moreover, the motions of the fore-arm, whether voluntary or passive, instead of taking place entirely at the elbow joint, are partly accomplished at the seat of the injury. The deformity resulting from this cause is very obvious when the fracture is at or below the insertion of the deltoid. There is very often a perceptible irregularity in the direction of the arm, which changes its form when the patient moves; and in all cases, the surgeon can produce a bending of the limb at the fractured part, by grasping the superior part of the bone and gently moving the elbow. Sometimes there is very obvious shortening of the limb produced by the original fracturing force; and this is a pretty sure indication that the fracture is either comminuted or very oblique. Extension applied to the elbow or fore-arm, readily reduces the limb to its natural length and general form. If it become necessary to determine accurately the direction of the fracture, this is readily done by passing the fingers of one hand along the bone, from near the internal condyle to the axilla, behind or within the inner edges of the biceps and coraco-brachialis muscles, while those of the other explore it along the outer side of the biceps, and the posterior margin of the deltoid.

When the fracture occurs considerably above the insertion of the last-named muscle, somewhat more careful examination is required; but though the deformity of the limb is not always visible to the eye at first, it cannot escape detection when the surgeon changes the position of the elbow, while his fingers are applied along the bone in or near the axilla.

These signs being amply sufficient to determine the nature of the case, we can scarcely express too strong reprobation of the course pursued by many who consider audible crepitation the only sure test of the existence of a fracture. That it generally occurs during the reduction of the accidents of which we are now treating, is true; but the attempt to produce it unnecessarily, as a means of diagnosis, is cruel and unwarrantable. The only cases which justify the trial by crepitation, are those in which the fracture is very oblique, and the surgeon dreads that, even after the apparent reduction, some portion of muscle or fascia may still be interposed between the fragments, in such a manner as to endanger the occurrence of a pseud-arthrosis.

Prognosis. Simple fractures of the arm generally unite with great facility. The ease with which the fragments may be kept in contact, and the certainty with which their malposition may be ascertained, whenever it occurs, render the patient less liable to pseud-arthrosis, when treated with ordinary skill, than in cases of fractures of the thigh. Comminuted fractures usually recover without difficulty, unless the injury done to the soft parts is very considerable. When complicated with an external wound the mechanical treatment is often rendered difficult, but the result is quite as favourable as in fractures of other bones. Although the os humeri is rather remarkably subject to necrosis from constitutional or internal causes, and though the parietes of the body of the bone are dense and hard, its proximity to the centre of circulation, and the number and activity of the vessels within and at the extremities, render it less liable to death from traumatic injuries and denudation of the periosteum. Splinters which retain their connexion with the soft parts, often reunite with great readiness, and the exfoliation that follows abrasion of the periosteum is generally superficial, unless the denudation is quite extensive. In simple cases, the new deposit generally acquires considerable firmness in three or four weeks, according to the age of the patient; and the danger of deformity from simple muscular action, is generally at an end. Still, the limb requires protection from all accidents, and cannot be used with safety for some time longer. The cure may be considered complete in five or six weeks, when the patient is vigorous, but all considerable exertions should be avoided for a much longer period. Complicated cases may require months for their recovery. (See Art. *Fractures.*)

Treatment. We might collect, if it were proper, a considerable variety of apparatus recommended at different times for the treatment of fractures of the humerus; but as most of these machines are either forgotten or have failed to obtain general sanction, and as the more important of them are applied, with some slight modifications, in other fractures, we shall avoid needless repetition and a vain display of learning, by neglecting those no longer in use, and by referring to the articles on *Splints*, and on *Fractures of the Elbow*, for a discussion of the merits of several others. In this place, we shall confine ourselves to a description of what is generally considered the best method of treatment on this side the Atlantic.

The indications in the mechanical treatment of the simple cases, are, 1st, to re-

duce the fracture; 2d, to secure the limb against œdema, or other ill consequences from the pressure of the requisite dressings; 3d, to secure the proper direction of the limb, by means of splints and compresses which will prevent all angular or lateral derangements of the fragments, from accidents or muscular contraction; and finally, to prevent deformity from rotation, and secure the perfect rest of the parts, by confining the fore-arm to the trunk.

To reduce the fracture, the patient should be seated, if possible; the surgeon then brings the limb to its full length and position by grasping the elbow or fore-arm with one hand, so as to make extension, while, with the fingers of the other, he assures himself of the proper coaptation. If considerable force be required, as is sometimes the case when there are great irregularities in the fractured surfaces, it is more convenient to flex the fore-arm, and, giving the hand into the charge of an assistant, make pressure on the front of the fore-arm near the elbow, to produce the extension.

To secure the limb against œdema, a roller should now be applied, commencing pretty tightly, at the base of the fingers, applied neatly about the wrist, and ascending by reverted turns gradually less firmly drawn, to the elbow. The fore-arm is then placed at right angles to the arm, with the elbow carried to a convenient distance from the side. An intelligent assistant holding the wrist of the patient with his left hand, continues gentle extension on the fore-arm with his right; while another, if the fatigue or weakness of the patient render it necessary, effects counter-extension, by passing his arms round the chest and interlocking his fingers over the acromion of the injured side. The surgeon then proceeds to envelope the whole surface of the elbow with accurate turns of the roller, and causes them to ascend, but with still diminishing tightness, to near the seat of the fracture. Two directions of surgical writers, of which we cannot entirely approve, require some notice at this stage of the dressing. It is recommended that the inequalities of the limb should be filled with compresses of cotton or other soft matter, before continuing the roller over them. In very muscular subjects, this measure may be well employed about the insertion of the deltoid, when the fracture is in another situation; but as it is much more difficult to regulate the action of compresses confined by a roller, than those attached to splints, we greatly prefer the latter arrangement. It is also recommended that two or three firm circular turns of the roller should be placed immediately over the site of fracture, to give additional security to the coaptation. This, we think erroneous in principle, and injurious in practice. The tightness of these turns, if they are so applied as to accomplish their intention, is sufficient to embarrass the circulation in the veins and lymphatics, and thus to thwart the main purpose of the whole bandage. Moreover, there is *here* no necessity for acting immediately on the injured parts, (*a necessity always to be regretted*), in order to secure the proper direction of the fragments, except when the fracture is located above the insertion of the deltoid; and when the shortness of the superior fragment compels us to resort to this measure, it is better accomplished by a longitudinal splint, or compress of moderate width, than by circular turns of a flexible roller. Rejecting or adopting these directions, then, the surgeon carries the roller regularly up to the shoulder, ascending by reverted turns over the deltoid; and here it is decidedly better to secure the first bandage, in preference to reserving the surplus of the roller, to descend with it, as some direct, over the remainder of the apparatus; which can never be done with neatness and security, except, perhaps, in patients very much emaciated. The superior part of this bandage should be applied as loosely as is consistent with security, as there is almost always some swelling of the limb after its application.

To fulfil the third indication, four splints, each about two inches in width, with rounded corners, are applied to the arm, in front, in rear, and on each side. The inner splint, which is the shortest, extends from the axilla to within an inch and a half of the point of the internal condyle, and should follow the interval between the edge of the triceps and the margins of the coraco-brachialis and biceps muscles. This is perhaps the most important of the splints, acting most directly on the bone, and requiring little or no graduation of the compress applied beneath it. It is necessary that this compress should be flat, and but little yielding, or it is very apt to arrest the circulation in the brachial artery,—one of the most troublesome difficulties in these, and certain other fractures of the superior extremity.

The outer splint extends from near the external condyle, almost to the acromion process. Its compress must be graduated

so as to fill the depression at the insertion of the deltoid, and this part of the compress should be firm and unyielding when the fracture occurs at or near this point; but if the soft parts are much contused, it may be so adjusted as to press with less force on the immediate seat of the injury. Much pressure immediately on the condyle should be likewise avoided.

The anterior and posterior splints are rather less important. They may be diminished in width when the limb is attenuated; but when the muscular development is great, they should be of corresponding dimensions, and their compresses should be graduated (particularly the anterior one) to suit the curvilinear form of the limb. There is an advantage in making these compresses of more yielding materials, as it gives a degree of elasticity to the apparatus without endangering the continued apposition of the fragments; the tendency to displacement from muscular contraction being mainly counteracted by the other splints, because such displacements are almost always either outward or inward, and scarce ever occur in the antero-posterior direction. These splints extend from nearly the same height with the outer splint, to the bend of the arm, and the olecranon, respectively. One of the main points in the application of this part of the apparatus, is to secure the freedom of circulation in the brachial artery, which courses between the anterior and interior splints. We prefer, for the lateral splints, compresses formed of muslin, graduated by being folded upon itself lengthwise, the folds being made most numerous where the greatest thickness is required. For the anterior and posterior splints, we employ fine tow or hemp; and all the compresses are secured to the splints by enveloping each set in a few turns of a roller. A variety of carved wood, or grooved tin splints, have been recommended for the treatment of these fractures; but nothing serves a better purpose than that which is at once most simple and most accessible, namely, a common cedar shingle, planed, and cut into slips of suitable dimensions, with a penknife.

When the limb is much attenuated, it is sometimes inconvenient to apply four splints; and when the fracture is seated high up toward the axilla, the parts which cover the superior fragment cannot always tolerate the pressure of the internal splint. In both these cases, the latter may be omitted, and a cuneiform graduated compress, slightly thickened at its superior extremity, and supported by a scapulary, may be substituted for it.

The splints being properly placed, and secured for the moment by an assistant, the surgeon applies over them a second roller, commencing at the elbow, and ascending, with occasional reverted turns if the patient be muscular, to the shoulder, where he secures it with a pin, and gives the roller in charge to an assistant, while he ascertains, from the condition of the thumb and fingers, that the tightness of the bandages does not occasion undue engorgement.

To fulfil the last indication, the elbow is brought to the side, the arm being slightly advanced; the fore-arm is suspended in a sling, and the surgeon then takes the remainder of the second roller, carries it round the chest, beneath the axilla of the sound side, to near the elbow; thence it is made to ascend by spiral turns around the chest, arm, and sling, to near the shoulder; and these turns are secured by a double or single scapulary secured to several of them both before and behind. A third and broader roller may be substituted, often with advantage, for the remains of the second bandage.

The greatest disadvantage of this apparatus is the liability of these long bandages to stretch and become loosened; but when well applied, they do not require frequent alteration, and the trouble of two or three reapplications is amply remunerated by the comfort of the patient, and his freedom from the inconvenience occasioned by the unequal pressure of straps and other evils attendant on the use of more complex machines. The plan here laid down, is similar in its principal features to that of Boyer (*Mal. Chir.* III. 190.): the minuter points which have been added may appear unimportant to some, but we feel confident that nothing has been stated that does not deserve attention.

After the fifth week, in the adult, it is often convenient to remove the apparatus and to involve the arm in wet pasteboard and a simple roller, the sling being still continued. In a week or two more, all treatment may be discontinued, in most cases.

Fractures of the body of the humerus complicated with external wounds, may require considerable modifications of the mechanical treatment, nor would it be possible to enumerate these. The union of the wound by the first intention should always be attempted, when not obviously impossible. When this fails, it is often

advisable, in bad cases, to place a carved, or moulded pasteboard splint on the uninjured part of the arm, to secure this by a Scultet bandage, and placing the patient upon his back, to support the whole limb upon a pillow, with the fore-arm in semiflexion, in an angular fracture-box.

The accidental injuries to vessels and nerves in these fractures, are noticed in the preceding article. The other complications, which are in no degree peculiar to this region, will be considered under the general head of *Fractures*.

REYNELL COATES.

§ 2. *Amputation of the Arm.* This becomes necessary, whenever a disease or accident calling for the removal of the member is situated so high up as to render the operation impracticable at the elbow joint. It may be performed either by the circular incision or the single or double flap, and upon any part of the arm, either above or below the attachment of the deltoid muscle. In all cases, however, the limb should be amputated as low down as the condition of the parts will admit, so as to secure to the individual all the advantages afforded by a long stump.

A. *Circular Incision.* This method of amputating the arm, originally proposed by CELSUS, has been adopted, with some modifications, by a majority of surgeons, since his time, and is still very extensively employed. Various modes of performing it have been proposed, all of which will be found to answer.

a. GRAEFE's *method.* The patient may be placed in a chair, or, as is recommended by GRAEFE, on a convenient table or the edge of a bed. If the member is to be removed below the insertion of the deltoid muscle, the artery may be commanded, either by pressure in the axilla, or by a tourniquet; if above that point, by pressure upon the artery where it crosses the first rib. The arm should be raised from the side of the body, and inclined a little forward, and the elbow slightly flexed. One assistant grasps the member immediately above the point at which it is to be amputated, and draws the soft parts forcibly upwards, taking care to increase the traction while they are divided with the knife, while a second supports it at the elbow. The operator, placed on the outside of the member, and armed with a common amputating knife, makes a circular incision through the integuments, which being drawn forcibly upwards by the assistant, the muscles are next divided by a bold circular cut carried down to the bone, the edge of the knife being at the same time directed obliquely upwards, so that while it revolves round the bone, it will divide the parts in such a manner, as to give to the face of the stump the character of a hollow cone, having its apex directed upwards. By adopting this procedure, there will be no necessity, as has been correctly observed by GUTHRIE, to dissect up the integuments, inasmuch as if the knife be directed obliquely, and the assistant is careful to make forcible traction of the soft parts, an ample covering can be obtained for the face of the stump.

In consequence of the biceps muscle being only attached by its extremities, it will sometimes retract, when divided, more than the other muscles, and impart an irregularity to the stump. To obviate this difficulty, SAMUEL COOPER proposes to divide it simultaneously with the integuments, by the first incision, so as to suffer it to retract before the knife is carried through the deep-seated muscles.

Having divided all the parts completely down to the bone, the retractor is to be applied, so as to draw up and protect the soft parts, and the bone is to be divided as high up as possible, by a few long and regular strokes of the saw.

The pressure being removed from the arm, the humeral artery, which will be found on the inner side of the bone, must be tied, as well as any other vessels which may require the ligature. The stump should then be carefully sponged, the soft parts drawn over the face of the stump from each side, and approximated in the direction of a line extending from the anterior to the posterior part of the arm, from the lower part of which the ligatures should be allowed to hang. Two or three adhesive strips supported by a roller, will be sufficient to maintain them in their situation, and support the stump.

In dividing the muscles in this operation, it is recommended by some surgeons, to carry the knife in a perpendicular direction down to the bone, instead of giving it the oblique inclination recommended by GRAEFE, and while the assistant draws the parts forcibly upwards, to insert the knife a second time upon the cone formed by the muscles, which adhere to the bone, and divide them by a second circular incision. This method will give to the face of the stump the same hollow or excavated character which is obtained by GRAEFE's procedure, and will likewise furnish a flap sufficiently large to cover the bone.

B. *With a double flap.* The application of the flap operation to the arm, when

it becomes necessary to remove it above the insertion of the deltoid muscle, was long since recommended by Louis, Leblanc, Sabatier, and Trecourt, and has been applied in more modern times, by Klein, Langenbeck, and others, to those cases in which the operation is performed at the usual point.

a. Klein's *method.* The arm is supported as in the preceding operation, and the artery commanded, either by pressure or the tourniquet. The operator, placed on the outer side of the limb, and armed with a double-edged catlin, seizes the soft parts upon the anterior part of the arm, between the thumb and finger of his left hand, and transfixes the member from without inwards, making the point of the knife glide round the bone, so as to come out opposite to the point at which it entered. Then carrying it obliquely downwards and forwards, it is brought out so as to form an anterior flap of two and a half or three inches in length. By a similar manœuvre, a posterior flap of the same dimensions is formed, the member being transfixed behind the bone, while the soft parts are drawn backwards. The assistant turns back both flaps, and supports them while the operator divides the remaining parts down to the bone, by a circular incision carried round the member, on a level with the base of the flaps. This done, it only remains to saw the bone, secure the arteries, and dress the stump, which is to be done in the manner already prescribed, with the exception, that the flaps are united from behind forwards, instead of from side to side, so that the cicatrix will be placed in a transverse direction.

By the same method of operating, one flap may be formed upon the inner, and the other upon the outer side of the arm. (Rust.)

b. Langenbeck's *method.* Langenbeck makes an anterior and a posterior flap, by cutting obliquely from the surface to the bone. Everything being disposed as directed above, an assistant supports the elbow, while the surgeon, placed on the outer side, for the left, and the inner, for the right arm, grasps the member below the point at which it is to be amputated, and makes an incision in an oblique direction from without inwards, and below upwards, terminating at the bone, so as to form a flap of sufficient dimensions. The first incision should be made posteriorly, on the left, and anteriorly, on the right arm. A second incision is next to be made in the same manner, upon the opposite side of the member, so as to form a second flap. Both flaps being turned back, the deep-seated parts are divided by a circular incision, and the operation is completed in the manner already described.

By this method, the arm may be removed with great celerity, but it possesses no advantages over that of Klein, and can not be so easily performed by one unaccustomed to the use of the knife.

c. Louis's *method.* In those cases in which it becomes necessary to amputate above the attachment of the deltoid muscle, La Faye long ago maintained, that it would be better to remove the member at the shoulder joint, than to amputate through the continuity of the bone, because of the great liability of the pectoralis major and other muscles to contract, and leave the bone naked, or the immobility of the stump, arising from the destruction of the principal muscles which are inserted into it. Larrey and Jobert have also, in more modern times, insisted strenuously upon the propriety of adopting the advice of La Faye; and even Guthrie affirms, that when the operation is performed in this situation by the circular incision, the bone will generally protrude after a few dressings. He nevertheless recommends, that the arm should be amputated immediately below the tuberosities of the humerus, in a manner presently to be described. Le Blanc warmly contested the propriety of the advice of La Faye, and notwithstanding the recent authority of Larrey and Jobert in its favour, few have admitted its propriety. The operation through the bone is less formidable than that at the shoulder joint, and the muscles which remain attached to the head of the humerus, will impress upon the stump sufficient motion to render it more or less useful to the individual. It was to meet the difficulties adverted to above, that the following method of operating was recommended by Louis, which is likewise advised by Sabatier.

An assistant compresses the subclavian artery where it passes over the first rib, while a second supports the arm elevated from the body, in a horizontal position. The operator, standing on the outer side of the member, makes a transverse incision through the integuments and the anterior inferior part of the deltoid muscle, from the extremities of which, he extends two others longitudinally, or rather somewhat obliquely, so as to form a trapezoid-shaped flap, at the expense of the anterior and external part of the muscle. This being dissected up and turned back, the remaining structures are divided by a cir-

cular incision down to the bone, after which the latter is sawed in the usual manner.

d. GUTHRIE'S *method.* Mr. GUTHRIE prefers removing the member about an inch, or an inch and a half, below the tubercles of the humerus. His method is precisely similar to the oval operation which will be described, for the removal of the arm at the shoulder joint.

The patient being seated, the artery is to be compressed where it crosses the first rib. Two incisions, of a similar shape, are to be commenced, one or two fingers' breadth below the acromion, as the case may require; the point of the inner one, instead of ceasing, as in the operation of the shoulder, a little below the pectoral muscle, is to be carried directly across the under part, to meet the point of the outer incision; so that the under part of the arm is cut by a circular incision, the upper in the same manner as in the operation at the shoulder. These incisions are only carried through the skin and cellular tissue, which are at liberty to retract, but are not to be turned up. The deltoid and pectoralis major are then to be divided close to the inner incision, and the opposite portion of the deltoid, on the outside, with the long head of the biceps, for the extent of the outer incision. A half-circular cut on the under part, in the line of the skin down to the bone, clears it underneath, and shows the artery retracting with its open mouth, which is at this moment advantageously pulled out with the tenaculum, and secured. The flaps are then to be turned back, and the bone sawed, after which, the vessels which may bleed must be tied. The flaps should be brought together so as to bring the line of union in a direction from above downwards.

This operation is well suited to fulfil the indications of the case, but we do not perceive that it possesses any advantages which may not be secured either by the operation with a double flap, or that by the oblique circular incision, recommended by GRAEFE, both of which are more expeditious, and easier of execution. In a case in which we had occasion, within a short time, to amputate the arm in the vicinity of the shoulder joint, the operation was performed in the following manner. The individual was brought to the edge of the bed with his arm extended to a right angle with the body. The artery was compressed by an assistant against the articulation of the shoulder, the great elevation of the clavicle, owing to the peculiar conformation of the chest, rendering it difficult to compress it over the first rib. Standing on the outside of the member, a long double-edged catlin was introduced about the middle of the deltoid muscle, a little below the acromion process, and thrust directly through, in front of the bone, so as to bring out its point in the axilla, behind the fold formed by the pectoralis major. The instrument was then made to cut itself out, by being carried obliquely downwards, and an anterior flap was thus formed, comprising half the deltoid and the outer portion of the pectoralis major. The knife was next insinuated at the same point, and thrust through in the same manner behind the bone, so that, in cutting itself out, a posterior flap of similar form and dimensions was made, consisting of the corresponding portion of the deltoid, and the latissimus dorsi and teres major. The flaps being turned back, a circular sweep of the knife around the bone, divided the deep-seated structures, and the operation was completed by sawing the bone, securing the artery, and adjusting the flaps so as to have their line of union placed in a perpendicular direction. Considerable embarrassment was experienced in securing the artery, arising from the retraction of the vessel within the axilla, and its being intimately surrounded by the nerves. Nearly the whole stump united, however, by the first intention, and none of the difficulties so much apprehended by surgeons were experienced.

C. *Single flap.* LOWDHAM'S *method.* The operation by the single flap has been submitted to various modifications. The following is the best method of performing it, when the arm is to be amputated below the attachment of the deltoid. Everything being properly disposed, the surgeon seizes the anterior face of the arm, and inserts the heel of a common catlin upon the inner part of the member, which he then conducts across, in front, to the opposite point on the outer side, making it describe a slight curve with its convexity downwards. By this cut, the integuments upon the anterior part of the arm, and the biceps muscle, should be divided down to the bone. The soft parts upon the posterior part of the arm, including the triceps, should next be grasped between the thumb and fingers, and drawn backwards, while the catlin, introduced at the angle of the first incision, should transfix the member behind the bone, and be brought out so as to cut a flap of sufficient extent to cover the face of the stump.

This operation is exceedingly simple,

but in performing it, the biceps should always be divided and suffered to retract, before the flap is formed from the posterior part of the arm; otherwise, the stump will be uneven, and the bone will be apt to protrude. E. GEDDINGS.

§ 3. *Resection of the Humerus.* It may become necessary, in consequence of necrosis and other conditions affecting the shaft of the humerus, to resort to the resection of a portion of the bone, more or less considerable, according to the extent of the disease. It is likewise often necessary to practise the same operation upon the extremities of the bone; but the method of doing this will be described under the heads of *Resection of the elbow and shoulder joints.*

Operation. When it becomes necessary to perform resection of a portion of the shaft of the humerus, the arm should be extended upon the edge of a table, or supported in a horizontal position by assistants. With a common scalpel or bistoury, a longitudinal incision of sufficient length, should be made along the outer bicipital furrow of the arm, parallel with the axis of the member. This should be carried successively through the skin, cellular and adipose tissue, and fascia, until the bone is fully exposed to the extent required. In order to isolate it from the surrounding muscles, the brachialis internus must be first carefully dissected from it in front, and the triceps behind, by carrying the knife close to the shaft of the bone. In this stage of the operation, the branches of the external collateral artery will be divided, and must be secured by the ligature. The radial nerve which twines around the posterior part of the humerus, to get upon its outer and anterior face, must be carefully avoided; and in order to prevent it from being injured, it should be cautiously isolated, and held to one side. The bone being thus exposed to the extent that may be desired, the resection must be completed by sawing through the shaft above and below, while the edges of the wound are held asunder and protected by means of a broad spatula. This part of the operation can be best achieved with a chain saw; but if that instrument is not at hand, a common Hey's saw will answer every purpose. Some caution will be requisite in isolating the bone, not to injure the brachial artery, which, throughout a considerable extent of the arm, reposes closely upon its inner and anterior surface.

After all the bleeding vessels have been secured, the coagulated blood should be sponged from the wound, and a pledget of fine lint interposed between its lips. Over this, light dressings should be applied, and the limb placed in an easy position, upon a pillow. The general treatment must be conducted as directed under the article *Resection.*

In some instances, in consequence of the violent contusions inflicted by gunshot and other causes, nearly the whole extent of the humerus becomes necrosed, and must be removed. Occasionally, indeed, it has been thrown off by the spontaneous efforts of nature, and no reproduction of bone following, the whole extent of the corresponding portion of the arm has remained perfectly flexible, and without any bony shaft to sustain it. We have seen a case of this kind, in which the destruction of several inches of the bone followed a violent contusion, and after becoming detached from the living portion, was thrown off through an opening in the soft parts. The arm, which remained flexible at the point, dangled by the side, but was, notwithstanding, of great use to the individual. JULES CLOQUET presented an individual to the Academy of Medicine, who, in the battle at Fleurus, had two-thirds of the humerus shot away. Some time afterwards the remainder of the bone was thrown off in a state of necrosis, and the wound healed. At the time he was submitted to the Academy, the limb hung only by the soft parts, yet could be employed to great advantage by the individual. (BÉRARD. *Dict. de Méd.* 2d edit. V. 592.) YVAN remarked at the time, that there were several individuals at the Hôtel des Invalides, in a similar condition. These facts render it probable, that should the necessity occur, the whole of the humerus might be removed by an operation. E. GEDDINGS.

§ 4. *Aneurism and ligature of the brachial Artery.* Every portion of the brachial artery, from the axilla to its bifurcation at the bend of the arm, is liable to aneurism; yet in consequence of the frequency with which it is punctured at the latter point, in the operation of venesection, aneurisms oftener form there, than upon other portions of the vessel. As we have separated the brachial region from the elbow, it does not fall within the scope of our present observations to consider aneurisms at the bend of the arm; we shall consequently leave them, to be described in connexion with the region to which they belong.

Aneurism is seldom developed upon the course of the brachial artery, except as a consequence of wounds, contusions, or

violent strains affecting the part; and even when extensive alterations of the coats of the vessel exist, some such exciting cause is generally necessary, to give rise to the disease. Such alterations are, indeed, of comparatively rare occurrence in the brachial artery, and very few cases have been reported, in which, when they did exist, they were followed by the spontaneous development of aneurism, without the concurrence of more or less violence or force. HODGSON remarks, that he had never witnessed such an event. PELLETAN reports a case, in which a large aneurism formed at the bend of the arm, in consequence of a diseased state of the artery, the coats of which were so much altered, that hemorrhage took place after the operation, and destroyed the patient. SCARPA, likewise, has referred to two cases, on the authority of PALETTA and FLAJANI. In one of these, however, the influence of force co-operated, the development of the tumour being induced by the artery giving way under the muscular exertion required in lifting a heavy body; and in the other, it is probable some force was employed, as the formation of the tumour was preceded by a crack, as though something had given way in the arm. (HODGSON. *Traité des maladies des artères et des veines:* traduit par BRESCHET. II. 142. Paris, 1819.)

Aneurism affecting the two upper thirds of the brachial artery, may be either diffused or circumscribed, according to the nature of its cause, or the period of its duration. As the vessel is superficial, and not tied down firmly by aponeurosis or muscle, the tumour is generally conspicuous, and can be easily recognized by its pulsations, and other characters peculiar to such affections. The same cause facilitates its diffusion and increase of size, and the tumour is not flattened and compressed, as it is in some other regions.

The termination of brachial aneurism presents nothing peculiar. When left to itself, its issue is the same as that of aneurisms in other portions of the vascular system, and is brought about by analogous changes. In the treatment of the disease, two procedures may be adopted, which, though they produce the same result ultimately, accomplish it somewhat differently. The first effects the obliteration of the aneurism by compression made upon the course of the artery: in the second, the obliteration is accomplished by a ligature applied to the vessel.

How far compression should be relied on as a means of curing aneurism of the brachial artery, is a question not yet satisfactorily decided. The size and shape of the member, the superficial situation of the vessel, and the closeness of its relations with the bone through the whole of its transit, which furnishes a solid point of resistance against which compression may be advantageously made, are all circumstances highly favourable to the success of this mode of practice. The course of the median nerve along the front of the artery may, however, constitute an objection, on account of the pain which might be inflicted by the long continuance of the pressure upon it. Although inconvenience from this cause is possible, we do not think it would be often realized, —and there are reasons for believing, that many cases of aneurism of the brachial artery might be successfully treated by compression, thus rendering it unnecessary to resort to a painful operation. We are the more confirmed in this sentiment by the fact, that several examples of cure have been reported by authorities entitled to full confidence,—and this success has been obtained, as well in cases of aneurismal varix at the bend of the arm, following injuries received in venesection, as in common aneurism of the brachial artery.

The means of making compression are so numerous and diversified as to render it inexpedient to enumerate or describe them. The object is to maintain an adequate degree of compression upon the course of the main trunk of the artery, without interfering with the collateral circulation. This cannot be done by a compress and circular bandage, applied in the ordinary way, but may be easily accomplished by any of the ordinary *press arteries*, or by a slight modification of the ordinary tourniquet. The most simple instrument of the first kind, applicable to the region under consideration, is a common elastic steel spring of the requisite strength, bent nearly into the shape of the letter U, with a small pad attached to each extremity. One of these pads should be fixed upon the course of the artery; the other, against the opposite side of the member, the spring being so curved, that by its elasticity, it will tend to make the pads approach each other. The common tourniquet may be used for the fulfilment of the same indication, if two short splints be provided, having a diameter a little greater than that of the arm. A graduated compress should be laid over the artery, upon which one of the splints is to be placed longitudinally; the other should

be placed upon the opposite side of the member, taking care to interpose a compress to protect the soft parts; and the strap of the tourniquet should then be buckled around the whole, so as to have the screw over the outer splint. A few turns of the instrument will be sufficient to establish the requisite degree of compression, which may be increased or diminished at pleasure.

In recent diffused traumatic aneurism, the compression may be made directly over the wound; but in those of longer standing, it will, in general, be better to establish it a little above. To insure success, it will be necessary to call into requisition the ordinary adjuvant treatment; as, the application of ice to the tumour, a strict antiphlogistic diet, perfect quietude, and other means enumerated under the article *Aneurism*. It is represented, that by acting on these principles, WINTER succeeded in curing a brachial aneurism in the person of the Queen of Bavaria. FLAJANI has also reported examples of success; and several cases of aneurismal varix, which were effectually cured by this procedure, have been published by BRAMBILLA (*Act. Acad. Cæsar Joseph.* I.), GUATTANI (*De spur. brach. Aneurism. Hist.* IV.), MONTEGGIA (*Instituzioni Chirurg.* I. 187.), and others. It is, moreover, stated by VELPEAU, that in the case of an individual affected with four aneurisms of the arm, of a year's standing, LISFRANC succeeded in arresting the progress of the disease, by the laced stocking. (*Méd. Opèratoire.* I. 211.). When a cure is effected by this process, it is generally by the obliteration of the artery. Yet the observations and experiments of WINTER, JONES, WESLING, WALTHER, and BECLARD, prove, that in some cases, a cure is accomplished without the vessel being closed. (RUST'S *Handbuch der Chirurgie.* II. 23.)

The *ligature* is unquestionably the most effectual means of curing aneurism of the brachial artery, and it is that which is almost universally resorted to. Nor is its application to this artery confined to the treatment of aneurisms affecting it alone; it is also extended to cases of this disease implicating the radial, ulnar, and interosseal arteries, high up in the arm; to wounds of those vessels taking place in the same situation, when the bleeding orifice itself cannot be found, or the wounded branch cannot be conveniently exposed; and, likewise, to wounds of the brachial artery itself. We learn from the records of the science, that the operation was performed by some of the early surgeons; yet it is a little remarkable, that even so late as the time of HEISTER, SHARP, and GOOCH, it was supposed, that when an aneurism was cured by it, there was a high bifurcation of the artery into its radial and ulnar branches, so that after one of them was tied, the other remained to carry on the circulation. (HODGSON. *Loc. Cit.* 139.) MOLLINELLI and WHITE first pointed out this error, and the correctness of their views has been fully proved by the investigations of more modern surgeons, and the brilliant triumphs which the science has achieved since their time. It is now well known, that when the trunk of the artery is obliterated, the collateral circulation, consisting of the free anastomoses between the superior and inferior collateral, the great anastomotic, and the recurrent branches, is amply sufficient to obviate any mischievous consequences likely to arise from the interruption of the main channel of the circulation in the arm. It is exceedingly rare for any bad effects to arise from defective circulation in the fore-arm, when the brachial is tied; but by no means uncommon, when this operation is performed for the cure of aneurism, for the pulsations of the tumour to recur after a few days, in consequence of its receiving a supply of blood from below, through the anastomosing vessels. This is indeed so much the case, as to render it necessary, in some instances, especially in aneurisms at the bend of the arm, to adopt the method of ANTYLLUS, and apply a ligature both above and below. (See *Elbow.*)

Operation. The individual may be placed in either a recumbent or sitting posture. In either case, the arm should be extended to a right angle with the body, upon a table, and the hand placed in supination. The operator, standing on the outer side of the member, draws a line from the middle of the axilla to the central point between the two condyles of the humerus. This line will represent the course of the artery, and will correspond to the ulnar border of the coraco-brachialis muscle in the upper half of the arm, and to the margin of the biceps from thence to the elbow. He may also ascertain the course of the artery by its pulsations, or, in lean subjects, by feeling for the median nerve, which, when the arm is extended, will be felt beneath the skin, ranging along the internal bicipital furrow, in form of a tense round chord, marking accurately the course of the vessel. If the artery is to be tied in the upper

third of the arm, with a common scalpel, he makes an incision through the integuments, two inches and a half or three inches in length, extending from above downwards on the right arm, and *vice versâ* on the left, carrying it along the course of the line previously traced, or, what is the same thing, along the inner border of the coraco-brachialis muscle. Having exposed the sheath of the vessels, the fore-arm should be slightly flexed, in order to relax the parts, while an assistant, with his fingers, or with blunt hooks, draws the lips of the wound asunder. A small portion of the aponeuroses investing the vessel should then be pinched up in the bite of the forceps, and carefully divided horizontally, so as fairly to open the sheath. By introducing the point of a grooved directory into this opening, the sheath may be further divided, if necessary, and the instrument carried beneath the artery, isolating it at the same time from the median nerve and the accompanying veins, and elevating it slightly from its bed. A ligature conducted by an aneurism needle, can then be passed beneath the artery and tied. As the median nerve, in the upper third of the arm, is on the radial side of the artery, the needle and ligature should be passed from without inwards, in order to avoid including it with the vessel; and great care will be requisite, to separate the two accompanying veins, one of which runs upon each side of the artery, which is sometimes overlapped by them. The ulnar and internal cutaneous nerves are on the ulnar side of the vessel, and must likewise be avoided. As they proceed downwards, they gradually recede, so as to be out of the way of an operation performed below the middle of the arm. Should any embarrassment be experienced by the wound becoming filled with blood, it can be easily remedied, by an assistant compressing the artery above, while another constricts the whole circumference of the limb below, so as to interrupt the course of the venous circulation.

When the artery is to be tied in the middle or the inferior third of the arm, the operation is performed in the same way, except that the incision is made along the inner margin of the biceps muscle, instead of that of the coraco-brachialis, and the needle and ligature are passed from within outwards, on account of the nerve being, in this part of the member, placed upon the inner side of the vessel. Should the incision fall upon the point at which the nerve crosses the artery obliquely, about the middle of the arm, greater caution will be requisite not to tie it up with the vessel. It will likewise be proper in all cases of high bifurcation of the artery, to ascertain, by making compression alternately upon both branches, before the ligature is applied, which of them communicates with the aneurism or wound.

One end of the ligature should be cut close to the knot, and the lips of the wound, after it has been sponged clean, should be brought together by adhesive strips, supported by a bandage, and the case treated so as to obtain union by the first intention. A little coldness and numbness of the fore-arm and hand are generally experienced for some time after the ligature is drawn, and the pulsation in the aneurism and at the wrist ceases; but in proportion as the collateral circulation becomes established, the limb regains its warmth, and the pulsation at the wrist is restored. E. Geddings.

ARNICA. (*Botany* and *Mat. Med.*)

Sex. Syst. Syngenesia Superflua.—*Nat. Ord.* Compositæ Corymbiferæ.

Gen. Ch. *Calyx* with equal leaflets, in a double row. *Seed-down* hairy, sessile. *Seeds* both of the disk and ray furnished with seed-down. *Receptacle* hairy Hayne.

The generic character of Arnica, as usually given in botanical works, is not accurate, and does not sufficiently distinguish this genus from Doronicum. Hayne asserts that the two genera are distinguishable only by the circumstance, that in Doronicum the seed of the ray is without pappus. In both, the receptacle is hairy and not naked, as commonly stated; and both have imperfect stamens in the ray florets. The only species of Arnica used in medicine is the *A. montana.*

A. montana.—*Mountain arnica*, *Leopard's-bane.*—*Arnique*, Fr.; *Berg-Wolverly*, *gemeines ächtes Fallkraut*, Germ.—*Sp. Ch.* "Leaves ovate, entire; cauline twin, opposite." Linn. *Sp. Plant. ed.* Willd. The root of this species of Arnica is perennial, nearly horizontal, about as thick as a quill, two or three inches long, abrupt, of a yellowish-brown colour externally, yellowish-white internally, and furnished with radicles rather lighter coloured than the body of the root. The stem is erect, round, hairy, from a foot to eighteen inches high, sometimes simple, sometimes furnished with one or two pairs of opposite branches. The leaves are sessile, oblong or lanceolate, pubescent, entire, nerved. The radical leaves, of which there are from four to six, are from two to

four inches long, from half an inch to an inch broad, obtuse, and marked usually with five nerves, rarely with seven; those of the stem are pointed, and in one or two opposite pairs. The flowers, which appear from May to August, are large, of a beautiful golden yellow colour, and solitary on the ends of the stem and branches. The calyx consists of from twenty to twenty-four linear-lanceolate equal leaflets, disposed in a double row, the exterior being rough-haired, and brown at the point. The florets of the ray are from twelve to twenty, ligulate, striated, three-toothed, and hairy at the base; those of the disk are numerous, funnel-shaped with a five-lobed margin, and rather longer than the leaflets of the calyx. The seeds are slender, two lines in length, five-sided, of a dark-brown colour, and crowned with a simple, hairy pappus. Two varieties of the plant are usually described;—α. *Alpina*, with a simple one-flowered stem and lanceolate leaves, and growing in mountainous regions; and β. *Vallium*, somewhat branched, with from three to five flowers and oblong leaves, and sometimes occurring in lower situations.

The mountain arnica is a native of Europe and Asia, growing in the northern parts of those continents, and found also in the mountainous regions further to the south. It is said to be indigenous in the higher latitudes of North America, west of the Mississippi. The root, herb, and flowers (*Radix, Herba, et Flores Arnicæ*) are designated as officinal by most of the European authorities. In the United States Pharmacopœia the whole plant is recognized under the officinal name of ARNICA. The flowers are thought to possess the peculiar virtues of the plant in the highest degree, and are the part most frequently employed.

The *roots* should be collected in the spring, and quickly but carefully dried. In the process of drying, they shrink, become wrinkled, and assume a darker brown colour. The dried *leaves* are of a pale green colour, particularly on the under surface; are thick; and have a firm, somewhat coriaceous consistence. Of the *flowers*, those only should be collected which are perfectly developed, and free from injury. They should be gathered on a clear day, and speedily dried. They frequently contain the eggs and larvæ of a certain insect, which, according to M. MERCIER of Rochefort, possess poisonous properties, and, when swallowed with the flowers, are apt to produce a burning sensation in the throat and stomach, gastric spasm, nausea, and vomiting. Hence it was proposed by BUCHNER, that, in gathering the flowers, the florets only should be preserved, while the calyx and receptacle should be rejected, as the parts in which the insects were most apt to be found. But the suspicion of their poisonous nature has not been confirmed by subsequent observation, and the symptoms attributed to them are such as the medicine itself not unfrequently occasions. Besides, according to GEIGER, the parts proposed to be rejected are even more acrid and bitter than the florets; and, as the observations hitherto made in relation to the medicine had reference to the whole flower, it would be improper to use portions of it in the doses and mode ordinarily prescribed, without further investigation. It is desirable, however, that the flower should be kept as free as possible from these larvæ; and it has, therefore, been recommended to dry them by placing them, immediately after collection, upon seives over a charcoal fire. In the choice of the dried flowers, those should be selected for use which have the sensible properties of colour, odour, and taste, in greatest perfection.

It is said that the Arnica flowers are very apt to be adulterated with those of other plants, particularly of different species of Inula, and Doronicum, from which, however, they may be distinguished by attention to their odour and taste, and to the characteristic form and structure of the different parts composing them. The flowers of the *Doronicum Pardalianches* and *scorpioides*, which might most readily be confounded with them, differ in having no seed-down in the ray-florets.

Sensible properties, and composition. The whole plant has a peculiar rather unpleasant aromatic odour, which is rendered more obvious when it is rubbed, and is then apt to occasion sneezing. The same effect is produced by the powder; and this circumstance has probably given rise to the name of *tabac des Vosges* by which the mountain arnica is known in some parts of France; though the origin of the name has also been ascribed to a fact stated by M. POMIER, that the flowers are apt, during desiccation, to become black, exhale ammonia, and acquire the odour of tobacco, as a substitute for which it is asserted that the plant is smoked by the peasants of the Pyrenees. The taste of arnica is acrid, aromatic, and bitter, and continues long in the mouth. The flowers are said to be more bitter than the leaves or root. The sensible properties and me-

dical virtues of the plant are extracted by boiling water.

The roots, according to Pfaff, contain in 100 parts, 1.5 of volatile oil, 6.0 of an acrid resin, 32.0 of extractive similar to the variety of tannin which colours the salts of iron green, 9.0 of gum, and 51.2 of lignin. In the flowers, MM. Chevallier and Lassaigne found a resin having the odour of the plant, a bitter principle analogous to that found by them in the seeds of the Cytisus Laburnum and hence named *cytisin*, gallic acid, a yellow colouring principle, albumen, gum, and saline substances. The flowers contain also a small proportion of volatile oil, said to be of a blue colour. The bitter principle, which might, perhaps, with propriety, be called *arnicin*, is yellow, of a bitter and nauseous taste, deliquescent, readily soluble in water and diluted alcohol, but with difficulty in strong alcohol, and insoluble in ether. It is powerfully emetic and cathartic in the dose of five grains, and is thought to be the active principle of the plant.

Effects upon the system, and therapeutic application. Arnica appears to be a general stimulant, operating upon the functions both of organic and animal life, and at the same time producing local effects such as usually result from acrid vegetable substances. It does not, however, give rise to that universal nervous excitement which characterizes the operation of the stimulant narcotics and antispasmodics, as opium, ether, alcohol, musk, &c. According to Richter, it excites the irritability and sensibility only of the lower organic structures, in which the lymphatics and veins predominate over the arteries and nerves. It operates, therefore, he observes, peculiarly upon the capillary vessels and the membranous and fibrous tissues, consequently upon the aponeuroses, the capsular ligaments, the synovial membranes, the periosteum, the pleura, the peritoneum, and the skin, exalting their activity, sometimes even arousing them from deep inaction, and, while it thus powerfully elevates the whole vegetative or organic process, opposing the commencing extinction of animal life, as exhibited in the colliquative condition and the putrefactive tendency.

The observable effects of arnica are the following. In small doses, it promotes absorption, and increases the secretions, particularly those of the skin, lungs, and kidneys. More largely taken, it produces, in addition, a strong irritative impression on the alimentary canal, evinced by a feeling of weight and uneasiness in the region of the stomach, eructations, nausea, sometimes painful vomiting, griping pain in the bowels, tenesmus, and dryish, ineffectual alvine discharges. At the same time, the pulse is increased in frequency and fullness, and symptoms of nervous disorder make their appearance, such as interior disquietude, anxiety, itching and pain in the urethra, glans penis, and scrotum, sudden and convulsive movements in different parts of the body as from electrical shocks, a feeling of constriction about the diaphragm, difficult respiration, a dry cough, and, in consequence of the propagation of action to the brain, pain in the head, vertigo, and drowsiness. It was first observed by Alex. Crichton, and the observation has subsequently been confirmed by the experience of others, that the use of arnica serves to indicate the parts of the body which may be the seat of disease, particularly when resulting from external violence, by the increased sensibility and even pain which it occasions in them. All the effects above enumerated are not experienced by every individual to whom the medicine is administered; and the system so readily becomes habituated to it, that after a short time, it ceases, if moderately used, to operate disagreeably. In over-doses, arnica is capable of doing much harm, and may even endanger life. Hence some caution is requisite in relation to the quantity administered; and Richter observes, that in small doses it is capable of fulfilling all the indications for which it is given, while nothing is gained by greatly increasing them. The best antidote to its poisonous operation is stated by Hahnemann to be vinegar.

From what has been said, it may be inferred, that arnica is adapted to the treatment of diseases in which there is a deficiency of vital power or action, whether general or local, as evinced by diminished sensibility, by a feeble circulation, by inactivity of the secretory organs, by obstructions and accumulations of all kinds resulting from deficient absorption, and by a tendency to decomposition and mortification. On the contrary, its use would be hazardous in cases of much general excitement, or of acute and active local inflammation, especially of the brain and alimentary mucous membrane; and it is necessary to be on our guard against its injurious operation upon the stomach and bowels, even when these are in a healthy state at the time of its employment.

The medicine does not appear to have

been known to the ancients; and MATTHIOLE was probably wrong in his idea that it was identical with the αλιςμα of DIOSCORIDES; as, according to the *flora Græca* of SIBTHORP, the plant is not to be found in Greece. (MERAT et DE LENS. *Dict. de Mat. Med.* I. 420.) It is known to have been employed in Europe so early as in the sixteenth century; and since the publication of the work of COLLIN in 1773, has attracted much attention, particularly among the German physicians. In England and France it is at present not very extensively used, and in the United States still less; but the confidence reposed in it by the practitioners of Germany, and the high strains of eulogy in which it is spoken of by the most enlightened medical authors of that country, entitle it to our respectful notice, even though we may be disposed to pronounce their praises extravagant. Perhaps the chief reason why the medicine is not more highly appreciated and more extensively used in this country, is the inferior quality of the parcels found in our shops, resulting from the deteriorating agency of time. For the following account of the complaints in which it is employed by the Germans, the author is indebted chiefly to RICHTER, in whose work on Materia Medica the subject is well and amply treated.

Perhaps the most useful practical application of the medicine is to the treatment of the different forms of fever in which the typhoid condition exhibits itself. When, in these complaints, the patient falls into a state of mental indifference or prostration, with diminished sensibility and a disposition to sleep; when the pulse is soft and feeble, the vision dull, the eyes turbid, the teeth, lips, and tongue, encrusted with sordes, the skin bathed in a cold clammy sweat or marked with petechiæ; in fine, when the evidences are presented of a general failure of the vital powers; arnica is habitually resorted to, and, as is asserted, with the effect of supporting the energies of the system, and favouring the resolution of the disease. It is, however, almost always, in such cases, given in combination with the diffusible stimulants or antispasmodics, such as valerian, camphor, ether, musk, &c., which are more powerful than arnica in their influence over the nervous system. VOIGTEL prefers the root in typhus fever, and considers it as peculiarly applicable to cases of great sluggishness of the abdominal viscera, indicated by tympanitic swellings, looseness of the bowels, fetid discharges of air, eructations, and a sense of weight and fullness in the belly. He connects its use with that of spirituous embrocations, spice poultices to the abdomen, volatile stimulants internally, and Peruvian bark. STOLL also particularly recommends the root in the symptomatic and colliquative diarrhœa of low forms of fever.

In the gangrenous tendency or condition, whether attendants upon fever or occurring in other affections, arnica is highly esteemed; and it is said to be given advantageously in small-pox, measles, and scarlet fever, when these diseases assume the putrid character, or exhibit a high degree of nervous prostration.

Even in intermittent fever it has occasionally been found successful, and is particularly recommended in cases of long duration, complicated with a peculiar morbid condition of the nervous system, sluggishness of the abdominal viscera, enlarged and indurated spleen, and œdomatous swellings of the belly and lower extremities. It is also applicable to intermittents of a typhoid or malignant character, and in these may be advantageously associated with bark. Fifteen grains of the powdered flowers, or from one to two drachms in the form of infusion, are given every hour during the apyrexia. The root is preferred when the complaint is associated with diarrhœa.

In the phlegmasiæ, arnica can be safely resorted to only when they are complicated with a prostrate or typhoid condition of the system, have terminated in gangrene, or have assumed a chronic form. RICHTER has employed it with distinguished success, combined with seneka, in the latter stages of peripneumony, when a universal torpid condition existed in connexion with a scanty, difficult, and viscid expectoration; and HUFELAND found it very useful in the same complaint in the forms which he designates by the terms *notha*, *nervosa*, and *putrida*. In dysentery it was employed successfully by STOLL, COLLIN, and HAHNEMANN; and it has been recommended in gout and rheumatism; but it is obviously inapplicable to the ordinary acute forms of these complaints.

As a remedy in the different hemorrhages, arnica has also found eulogists; and it may have done good in the purely passive form of these diseases; but as they ordinarily appear, it would probably be productive only of mischief.

To the feeble forms of dropsy, and to all cases of extravasation either sanguineous or lymphatic, it would appear to be adapted by its property of promoting ab-

sorption, and in the latter affections it is considered as one of the most effectual remedies. It is possible that in this way it may have proved useful in obviating the effects of falls, blows upon the head, and other external violence, in the treatment of which it has for a long time enjoyed much reputation both as an internal and external remedy, so as to have acquired among the Germans the popular name of *Fallkraut*, and with the learned that of *panacea lapsorum*. By promoting the absorption of fluids effused within the cranium or spinal canal, it may tend to relieve the paralysis occasioned by the pressure of these fluids upon the brain and spinal marrow, and by a similar operation upon effusions exterior to these cavities, may, in some measure, remedy those embarrassments in particular parts resulting from pressure upon the nerves which supply them.

As a remedy in epilepsy and other convulsive and spasmodic diseases, it has been abundantly lauded; and may have proved serviceable in cases dependent on general nervous debility, or disturbance in the stomach and bowels, or, as in some instances of epilepsy, upon bloody, purulent, or serous collections within the cranium or spinal canal.

In paralytic affections it has acquired great credit; but, according to RICHTER, is applicable only to such cases as have their origin in organic lesions. It has before been stated, that arnica is thought to have been found especially useful in that paralytic condition both of the external and internal parts of the body which follows violent bruises and concussions. It has also been used in hemiplegia succeeding apoplexy, in paraplegia, and in the various partial palsies proceeding from lesions of the spinal marrow or nervous textures of the abdomen. It has shown itself peculiarly serviceable in palsy of the bladder and lower extremities. Numerous cases are recorded of its successful employment in amaurosis, and HUFELAND found it effectual in the cure of a case of deafness. RICHTER states that much good can be expected from it only in recent cases of palsy, and that in such as are of long duration it generally fails. Thus he observes, that in the palsies consequent upon apoplexy, it must be given within the first six weeks in order to produce any good effect.

Finally, according to RICHTER, some good may be expected from arnica in all possible forms of disease, in which there is a call for a strong excitement of the lymphatics, and an elevation of the nervous and vascular activity in structures more especially devoted to the functions of organic life; consequently in all kinds of glandular swellings, and the atrophies and scirrhosities of the liver, spleen, and lungs, dependent thereon; in blenorrhœas of every kind; in chronic humoral asthma; in chronic diarrhœas whether atonic or colliquative; in old catarrhs; in high grades of hypochondriasis, hysteria, jaundice, &c. To these complaints it will always be more or less applicable, according as the system at large, or the diseased parts in particular, shall be more or less deficient in vital power and reaction. KAUSCH considers it the most effectual remedy for the ague-cake. HAHNEMANN praises it highly in habitual dizziness with constipation; MURSINNA, in a sluggish state of the bowels with tenesmus; and WEICKARD, in the exhausting diarrhœas arising from relaxation. It may be tried in habitual vomiting from atony of the stomach, and often affords relief in the colliquative diarrhœas of phthisis.

In the above account of the practical application of arnica, it has been the object of the author to present the views of the German physicians, whose high opinion of the remedy, founded on much experience, may possibly lead to a more extensive trial of its powers by the medical practitioners of this country.

Dose and mode of administration. In all chronic complaints, it is proper to begin with a small dose of the medicine, and gradually to increase it till some positive effects are experienced. In typhus fever and other acute diseases, good can be expected only from large doses at once. It may be given in powder, infusion, or decoction. The dose of the powder is from five to ten or twenty grains, which may be administered with syrup or honey, in the form of an electuary. The infusion, which is usually preferred, may be prepared in the proportion of from one to four drachms to half a pint of boiling water. and the whole may be given in the course of twenty-four hours. The infusion of the flowers should always be strained through fine linen, in order to separate the small fibres which might otherwise irritate the throat. Slight boiling renders the preparation more efficacious by enabling the water more thoroughly to extract the active principles. An extract and tincture of arnica are directed by some of the European Pharmacopœias. The dose of the former is from five to fifteen grains; that of the latter, made in

the proportion of one ounce and a half of the flowers to a pound of rectified spirit, is from fifteen to thirty drops several times a day.

Arnica is employed externally in the form of poultice, and of embrocation with the decoction or tincture. The powder is sometimes sprinkled on mortified parts. The remedy is also used by way of enema in typhoid complaints and asphyxias.

Geo. B. Wood.

AROMATICS. The substances forming this class of medicinal agents all belong to the order of stimulants or excitants, and are characterized by a mild and fragrant or strong and pungent odour, and a warm or acrid taste. Boerhaave and the earlier chemists supposed that these qualities were dependent on a peculiar principle inherent in certain bodies, and which could be readily obtained in an isolated state; but recent and more extended researches have demonstrated, that they are common to a great variety of dissimilar bodies. In the vegetable kingdom, aroma is in most cases owing to the presence of *volatile oil* (q. v.), and almost every stimulant plant yields this in greater or less abundance, and when isolated from the other principles which accompany it, it will be found to produce all the exciting effects of the entire vegetable in an increased degree. This is peculiarly the case in certain natural orders of plants, as the Labiateæ, Laurineæ, &c. This essential oil is in some cases contained in glands visible to the naked eye, whilst in others it is so intimately combined with other principles as to be separated only by long and tedious processes.

In some substances, as musk, bitter almonds, &c., it has been shown by Robiquet that the aroma is not exclusively owing to the volatilization of the volatile oil or even of particles of the body itself, but requires the presence of ammonia to develope its peculiar properties. According to the same chemist, the aroma of the Crucifereæ depends, in all probability, on the union of some volatile principle with sulphur. In fact, as has been observed by Ratier (*Dict. Prat.*), the odour of aromatic substances most frequently depends on the presence of a volatile body, but in other cases arises from new combinations of their principles with certain bodies, by which they acquire odorous properties.

The aromatic principle is sometimes found in all parts of a plant, as in the Labiateæ; in others it resides almost exclusively in the root, as in the Scitamineæ, whilst, in the Umbellifereæ, the seeds are, in general, most strongly imbued with it; and again, in some few species, the flowers, or only their most delicate parts, as the stigmas, contain this principle. It is often in intimate combination with some other peculiar bodies, as in the resins, in musk, &c., and is sometimes modified by the presence of other active constituents; thus, in the shaddock, the most intense bitter is united to the fragrant odour peculiar to the Aurantiaceæ.

Aromatic substances are stimulating and tonic, and have been variously classed as carminatives, aphrodisiacs, antispasmodics, &c. (q. v.). Their most general use is as condiments, to increase the flavour of food and to aid the digestive process by the transient excitement they produce in the stomach; for this purpose they are in general use in all warm climates, where their employment would appear to be almost indispensable to restore the tone of the system exhausted by the effects of the high temperature.

As medicinal agents, the use of aromatics is indicated in cases of atony of the digestive organs where there is an absence of all symptoms of irritation and inflammation. They are also habitually employed to disguise the nauseous taste or smell of many remedial articles.

R. E. Griffith.

ARROW-ROOT. — Maranta, Ph. U. S. — *Arrow-root*, Fr.; *Amerikanisches Stärkmehl*, *Arrowmehl*, Germ.

This name was originally applied to a variety of starch procured from the roots of different species of Maranta, particularly the *M. arundinacea*, an herbaceous perennial plant, growing spontaneously in the warmer latitudes of America, and cultivated abundantly in the West Indies. (See *Maranta*.) Similar products, derived from various other sources, have subsequently come into use, under the same name. Thus, a fecula is prepared in South America and the West Indies, from the root of the cassava plant, *Jatropha Manihot*, which is sold as arrow-root both in Europe and this country. In the East Indies, particularly in Travancore, upon the Malabar Coast, an excellent variety of arrow-root is said to be prepared from the root of the *Curcuma angustifolia*, which has become a considerable object of trade, and is highly valued in England. (Ainslie. *Materia Indica.* I. 19.) Within a few years, a fecula has been imported from the Sandwich Islands, and sold as arrow-root in the shops, which is probably procured from the root of the *Tacca pinnatifida*, a native of Tahiti and other islands

of the South Pacific. Finally, very pure potato starch has lately been substituted, to a considerable extent, for the product of the Maranta, under the name of potato arrow-root. All these varieties of fecula, when carefully prepared, are essentially the same in chemical composition and medicinal properties; but close examination has detected slight differences between them, and, as ordinarily kept in the shops, they are apt to retain, to a certain extent, the flavour of the several plants which yield them, so that they may often be distinguished by an experienced palate. This is especially the case with the potato starch and the cassava fecula, the latter of which not unfrequently has a feeble odour and a slightly acrid taste, and, according to M. O. Henry, has sometimes been productive of unpleasant results when given by injection, probably in consequence of a portion of the poisonous principle of the root having been allowed to remain in it, from insufficient washing in its preparation. (*Journ. de Pharm.* XX. 624.)

Genuine arrow-root is obtained in the following manner. The roots of the Maranta, having been carefully washed, are beat into a pulp, which is thrown into water, and agitated so as to separate the amylaceous from the fibrous portion. The latter is removed by the hand, and the water, holding the former in suspension, is strained through coarse linen, and then allowed to stand in order that the fecula may subside. This is washed with a fresh portion of water, and afterwards dried in the sun. Arrow-root is brought to us from the West Indies. As kept in the shops, it is in the form of a light, white powder, or of small pulverulent masses, without odour or taste. Chemically considered, it is pure starch, and therefore possesses all the properties which characterize this proximate principle of plants. (See *Starch.*) It is very apt to become musty by long keeping and exposure, and is then unfit for use. We are told that it is occasionally adulterated with different kinds of meal or flour; but these may be readily detected by their imperfect solubility in hot water. The presence of common starch, which is said to be sometimes fraudulently added, is not so easily ascertained. According to Guibourt, the granules of arrow-root are larger than those of wheat starch, more shining, and, when examined through a microscope, are entirely transparent, so that the powder in mass has a less brilliant whiteness. They are, on the contrary, smaller than those of potato starch, from which they also differ, as asserted by M. Walsh, in exhibiting, under the microscope, two circular impressions instead of one. (*Journ. de Pharm.* XIX. 432.) Besides, arrow-root imparts less consistence to boiling water than either of these varieties of starch. The best method, however, of testing the purity of this fecula is by the taste and smell. It should be entirely free from odour and unpleasant flavour.

The cassava fecula, which it may sometimes be important to distinguish, is apt, as before mentioned, to have a feeble odour, and a taste slightly acrid. It imparts less consistence to water, in the same proportion, than either genuine arrow-root, or the starch of wheat or the potato. According to M. Walsh, both this and arrow-root are sensibly dissolved by cold water.

Medical properties and uses. Arrow-root is a light, mild, easily digested, and, at the same time, nutritious article of diet, well adapted to the sick and convalescent, and much used in all febrile and inflammatory complaints, particularly in those of the bowels and urinary passages, in which it is peculiarly useful in consequence of its demulcent properties. It is much employed as food for infants, either after weaning, or when the mother's milk is deficient. The best method of preparing it is simply to dissolve it in boiling-hot water, with which it forms a pearly, gelatinous solution, or, if in large proportion, a jelly-like mass, on cooling. It should first be made into a paste with a little cold water, to which the hot water should be gradually added, with brisk agitation. The proper proportion is about a tablespoonful of the fecula to a pint of water. The preparation may be rendered more palatable by lemon-juice and sugar, and wine and spices may be added in cases requiring or admitting the use of stimulants. For infants, it is often prepared with hot milk or a mixture of milk and water, instead of water alone.

Geo. B. Wood.

ARSENIC. *Black Arsenic, Arsenicum, Arsenikon,* was first mentioned under this name by Dioscorides, and others, about the Christian era. Aristotle, under the term *sandarach,* and Theophrastus that of *arrenikon,* referred to a mineral of a reddish colour, composed of arsenic and sulphur, used by the ancients in painting and medicine.

The white oxide of arsenic is mentioned by Avicenna, in the eleventh century; but metallic arsenic is not distinctly al-

luded to until 1649, when Schroeder described a process for obtaining it. It is, however, to Brandt that we are indebted for the earliest accurate account both of arsenic and its white oxide. Since his time (1733), arsenic has been, under that name, considered as a distinct metal.

§ 1. *Chemical and Pharmaceutical History.* It is found native, or in alliance with copper, lead, silver, antimony, cobalt, tin, &c., in Saxony, Bohemia, Hungary, Siberia, Norway, England, &c. It is also detected in the state of an oxide, a sulphuret, and an arseniate. Sometimes it is volatilized from volcanoes, commingled with other volcanic products.

Arsenic has a brilliant steel-gray colour, easily tarnished by exposure to the air, a circumstance probably dependent on some slight adulteration, since both Berzelius and Buchner observed that some specimens remained perfectly lustrous in open vessels for a very prolonged period of time. Its texture is generally granular, occasionally scaly, and so loose as to be readily reduced to powder. It is, indeed, the most friable of the metals. It is volatile, combustible, insipid, and inodorous. Thrown upon burning coals, it gives off a whitish vapour, and an alliaceous odour. A plate of copper exposed to its fumes is covered with a white coat.

Its specific gravity varies so much, in accordance with the means by which it is obtained, as to have led to great difference in the amount, stated by different authors. Brandt set it down at 8.308, Bergman 8.31, Berzelius 5.70, Turner 5.8843, and Guibourt 5.959. As Dumas states it at between 5.75 and 5.76, a weight nearly the same as that given by Berzelius, that is to be presumed to be the most accurate. Our own experiments fix the specific gravity of arsenic at 5.767. (*Journ. Col. Pharm.* IV. 108.)

Arsenic has so strong an affinity for oxygen, that it is tarnished by exposure to the air, or when immersed in water or alcohol. Insoluble in those liquids, it is so changed by oxygenation, when boiled in either, as to acquire solubility, and thus by degrees communicates to them poisonous qualities. According to Hahnemann, a thousand grains of water in active ebullition over the metal, take up a grain of the oxide in the course of half an hour.

Although the great volatility of arsenic is admitted by all, authors have entertained different opinions respecting the degree of heat necessary to its conversion into vapour. Bergman stated it at 365°, Klaproth 540°, Thenard and Berzelius 324°, and Christison and Turner 356°. Dumas remarks that in closed vessels it is volatilized at nascent red heat, while, in the air, its sublimation is sensible at 324°. We found the temperature at which its vapour is given off in *open* glass tubes, to be *a red heat distinctly visible in the dark.* (*Amer. Journ. of Med. Sc.* for May, 1832.) When slowly sublimed, arsenic is sometimes found crystallized in octaedrons, and sometimes in tetraedrons, the latter being esteemed the integrant molecule.

It has been said, and Thenard sanctions the opinion, that arsenic may, under pressure, be fused and cast into moulds. Berzelius doubts the truth of this statement, so that as yet we may consider the question of fusibility unsettled.

All authors of modern date concur in ascribing the peculiar odour of sublimed arsenic to the vapour of the pure metal, while those of an older period refer it to the white oxide. In the essay already cited, we have given reasons for believing it to depend on neither, but to be the effect of volatilized *suboxide;* since the white oxide is entirely destitute of smell, and metallic arsenic is not volatile at, or near to, the temperature at which the odour is appreciable, a temperature at which the suboxide is usually vaporized.

Arsenic, in consequence of its insolubility, is not itself poisonous; but as it is readily converted, in the stomach, into soluble and poisonous compounds, its administration in large doses will always prove hazardous.

The equivalent of arsenic, deduced experimentally by Berzelius from the composition of arsenious and arsenic acids, is 37.7—a number adopted by Dr. Turner in his latest work. Thomson, and most other authors, assume 38 as its equivalent.

The black arsenic of commerce is obtained from the white oxide, or arsenical pyrites of good quality. The distillation is conducted in earthen retorts coated with a mixture of clay, iron filings, blood, hair, and alum. The receiver, formed also of earthen-ware, is pierced with some holes to prevent an explosion. An *adopter*, formed of sheet iron rolled up so as to make a tube, enters into, and connects the necks of the retort and receiver. The retort is made two-thirds full of the arsenical compound, mixed with charcoal, iron filings, and lime. After luting the retort, it is placed in the fire of a galley-furnace, the receiver being on the outside, and heat is kept up moderately for eight hours; after which the whole is

suffered to cool. The iron adopter, when removed and unrolled, displays the metallic arsenic in brilliant crystals. In the neck of the receiver is found a mixture of black and white arsenic, while an impure black arsenical powder is collected from the receiver itself.

On a smaller scale, metallic arsenic may be procured by sublimation in a crucible, to which another one, in an inverted position, is adapted by luting; or, on a still smaller scale, in a glass tube, sealed at one end, and heated by an oil or spirit-lamp. When the white oxide is used, charcoal will suffice for the reduction; but when the sulphuret is applied to, lime, potash, or iron filings, are necessary to detain the sulphur. In the glass tube, the arsenic collects just beyond the verge of red heat, in a shining ring, not much inferior to mercury in colour and brilliancy.

When arsenic is exposed, even for a short time, to the air, it loses its lustre, grows blacker and blacker, and often, in process of time, falls to powder. This substance, called Fly-stone (*fliegenstein*, Germ.; *poudre à mouches*, Fr.), was long esteemed a mixture of metallic arsenic and its white oxide. It is certainly true, that when fly-stone is put into a glass tube, and heated, it is separated into white oxide and the metal; but Berzelius, to whom we are indebted for the examination of this substance, considers it a suboxide, consisting of unknown proportions of arsenic and oxygen. The limit of absorption of oxygen by cold powdered arsenic, seems to be eight per cent., so that 100 parts of metal take 8 of oxygen. If this be a definite compound, it must consist of 8 atoms of arsenic and 3 of oxygen.

Arsenious Acid, *Arsenic of commerce*, *White Arsenic*, *White Oxide of Arsenic*, *Rat's-bane*, is the best known and most common of the preparations of arsenic. Once called white oxide of arsenic, because its acid properties were unknown, it is now, both by composition and character, placed by the side of phosphorous and hyponitrous acids. It is volatile at 425° F. (*Journ. Col. Pharm.* Vol. IV.), and when recently sublimed, presents octaedral crystals of adamantine lustre, or an amorphous vitreous mass equally transparent. According to Wöhler, it is dimorphous, assuming, under unknown circumstances, the form of six-sided scales derived from a rhombic prism. Exposed to time and air, it loses its transparency, becomes opaque, less hard, and decreases slightly in density. The specific gravity of the vitreous acid is 3.699 (Wollaston), 3.7386 (Guibourt); that of the opaque variety, 3.729 (Harepath), 3.695 (Guibourt). Dr. Turner states the specific gravity of vitreous arsenious acid to be 3.7. According to our own observations, the compact opaque variety is 3.656, the vitreous from 3.208 to 3.333. It is not easy to conjecture the cause of the conversion of vitreous into opaque arsenic, but moisture seems essential to the change.

It has been generally asserted that the white variety is more soluble in water than the other, and Guibourt's authority goes to show, that while 0.96 parts of the glass are soluble in 100 parts of cold water, the same quantity of water will dissolve 1.25 parts of the opaque variety. According to the same authority, 100 parts of boiling water dissolve 9.68 of the first, and 11.47 of the other; and when the temperature falls to 59° F. the solution of vitreous arsenic retains 1.78, and that of the opaque variety 2.9. If these experiments can be perfectly trusted, it is probable that, as in the case of phosphoric and pyrophosphoric acid, these two compounds of oxygen and arsenic are *isomeric*, agreeing in composition and equivalents, but modified by internal atomic relations. We made, on this subject, experiments (*Journ. Franklin Inst. Loc. Cit.*) which throw some doubts on the correctness of Guibourt's observations. We found that the vitreous arsenic required longer boiling than the white variety, but that finally, solutions of both were obtained, agreeing in specific gravity. We also found the arsenious acid more soluble in boiling water, than has been stated by any authority whatever. In our hands, one thousand parts of water, at 60° F., dissolved from 12 to 16 parts of the white arsenic; and the same quantity of boiling water, when fully saturated, held in solution 148 parts, and retained, on cooling, from 25 to 40 parts. The very singular effect of prolonged time, both on the quantity dissolved, and that retained after refrigeration, is worthy of particular attention.

The point of fusion is a little higher than that of sublimation, so that it can be melted only under pressure, or when the temperature is so suddenly raised as to melt the mass, before the whole is vaporized.

The taste of arsenious acid is said by Bergman to be acid, subdulcid; Hahnemann, Dr. James Gordon, and Walker, think it sweet; Addington and Christison esteem it insipid; Zacchius, Orfila, Berzelius, Foderé, &c., declare it to be sharp and acrid; while Dr. Turner

is satisfied, from personal observation, that it may be deliberately tasted without exciting more than a very faint impression of sweetness and perhaps of acidity. These discrepancies arise probably from the variety in the modes of observation. We think that the taste of a strong hot solution is rough, as stated by NAVIER; while that of the powder, or a weak cold solution, is so feeble as to be indescribable, and scarcely to be perceived by common palates. When most distinct, it is very nearly the same with that of *a solution of sulphate of zinc.*

White arsenic, in a pulverulent form, is obtained as a secondary product, in the chambers, or prolonged chimneys, attached to furnaces used for roasting or smelting various ores, especially those of cobalt, lead, and tin. Arsenical pyrites are also roasted expressly to obtain this product. It is afterwards purified and consolidated by sublimation in large iron mattrasses. In the laboratory, it may be made by heating the metal in open vessels, or by digesting it in *dilute* nitric acid.

The arsenious acid of commerce is in vitreous masses, of which the interior is almost perfectly transparent, while the exterior presents a white or milky appearance.

Besides water, alcohol, oils, and acids, dissolve white arsenic; but in general, organic products lessen greatly the power of any liquid solvent; so that even when white arsenic is adherent to the coats of the stomach, or is found commingled with the contents of that organ, it may not be detected in the liquid obtained by filtration.

Solid arsenious acid is readily detected by the alliaceous odour and white fumes, mixed with *umber-looking vapour*, which arise, when it is thrown on red-hot charcoal. When the quantity is too small to admit of such an experiment, it may be mixed with powdered charcoal, placed in the bottom of a glass tube sealed at one end, and cautiously heated to redness over a small spirit-lamp. The production of a brilliant steel-gray ring indicates the presence of metallic arsenic. By cautiously chasing the arsenic by heat, from one part of the tube to another, it is convertible into octaedral crystals of arsenious acid, whose adamantine lustre is farther evidence of the presence of arsenic. One or two of these, thrown on burning coals, will, by the peculiar odour of garlic or phosphuretted hydrogen, complete the evidence of the detection of arsenic. A very critical observer may choose to dissolve a part of both the metal and oxide, and resort, for full assurance, to the liquid tests.

In *simple aqueous solutions*, the detection of arsenious acid is remarkably easy.

1st. Ammoniated sulphate of copper throws down an apple-green flocculent precipitate of arsenite of copper.

2d. Ammoniated nitrate of silver causes a canary-yellow arsenite of silver to fall.

3d. Lime-water throws down white insoluble arsenite of lime.

4th. By means of sulphuretted hydrogen, or its aqueous solution, a yellow sesqui-sulphuret of arsenic (*orpiment*) is formed. To develope this precipitate fully, the solution should be heated, or there should be added a drop or two of hydrochloric acid. In any case, the precipitate is very suddenly produced. This reagent will detect arsenic in a solution containing the $\frac{1}{100,000}$ of its weight of the poison.

5th. The soluble hydrosulphates do not disturb the solutions of arsenious acid, until a drop or two of a strong acid is added, when there suddenly appears a yellow precipitate of sesqui-sulphuret of arsenic.

6th. By means of black flux and the heat of a spirit-lamp, any of the foregoing substances may be made to produce, in a glass tube, a bright metallic crust, whose characters may be farther examined by ignited charcoal, oxidizement, &c. &c.

By the combustion, in pure oxygen, of a known weight of regulus of arsenic, and the measurement of the quantity of the gas absorbed in the process, THENARD determined the composition of arsenious acid; which consists of

2 atoms of arsenic	= 940.77	or	75.82
3 atoms of ox.	= 300.00	or	24.18
1 atom of ars's acid	1240.77	or	100.

BERZELIUS analytically confirms THENARD'S synthesis; so that we may consider arsenious acid as composed of, in round numbers, 3×8 ox. and 2×38 arsenic; or $2\,As + 3\,O$, or $\dddot{As}$.

ARSENIC ACID is of a milk-white colour, has a sour metallic taste, reddens vegetable blues, and combines with alkalies, so as to form salts termed arseniates. It is much more soluble in water than arsenious acid, being dissolved by five or six times its weight of cold, and a much smaller proportion of hot water. It is remarked by BERZELIUS that it partakes of the property of phosphoric acid, inasmuch as it resists, even in fine powder, immediate solution, but is, by agitation, finally completely taken up.

When entirely anhydrous, arsenic acid attracts atmospheric moisture, and is reduced in density to 1.935. To its greater solubility, probably may be ascribed its superior poisonous quality. It is totally deprived of water at a temperature below red heat, and has a specific gravity of 3.39. At red heat it is partially decomposed, presenting then a melted mass composed of both the acids of arsenic. At a higher heat, it gives off oxygen, and is transformed into arsenious acid, which is volatilized.

Its composition, on the authority of Berzelius, is, of oxygen, 5 atoms, or 34.72; arsenic, 2 atoms, or 65.28; = 100.00.

Mitscherlich has shown that phosphoric and arsenic acids have the same relation to each other as the sulphuric and selenic. Saturated by the same bases, they furnish salts of the same crystalline form, or they are *isomorphous;* and, as is remarked by Berzelius, it was this very example of such relation which led the great crystallographer to the doctrine of *isomorphism*, now esteemed so important to the science.

Arsenic acid is made by boiling eight parts of arsenious acid with two parts of strong hydrochloric acid, with the gradual addition of twenty-four parts of nitric acid of the specific gravity 1.25. The mixture, after distillation in glass to the consistency of a syrup, should be transferred to a platinum capsule, and exposed to a heat below redness for a considerable time. The complete expulsion of water, and redundant nitric acid, leaves anhydrous arsenic acid.

Chemically, this substance may be detected in the solid state by its alliaceous odour when heated on charcoal, by its taste, its solubility, and by its reduction by heat and charcoal in a glass tube, in which the arsenical crust will be formed.

From simple aqueous solutions, it is precipitated,

1st. by acetate of copper, of a blueish white (arseniate of copper);

2d. by nitrate of silver not acid, brick red (arseniate of silver);

3d. by sulphuretted hydrogen, a yellow sulphuret is precipitated, whose composition is like that of the acid, containing, according to Berzelius, 2 atoms of metal and 5 of sulphur, or As^2Ss^5.

If farther evidence be desirable, the precipitates may be submitted to reductive processes, and the crust tested in the various modes by which the presence of metallic arsenic is manifested.

Two Hydrurets of arsenic are known at present. One, a solid, consists of one equivalent of each constituent; the other, a gas, is composed of two atoms of arsenic and three of hydrogen condensed into two volumes.

The *Protohydruret* was first noticed by Ritter. Davy formed it by galvanic reaction on water, when a piece of arsenic was attached to the negative pole. Soubeiran, on the contrary, could produce it only by submitting an alloy of arsenic and potassium to the action of water.

It is a chestnut, or chocolate-coloured solid, insoluble in water, and capable of bearing, unaltered, in nitrogen gas, a cherry-red heat. Heated in oxygen, it catches fire, and produces water and arsenious acid.

Its composition, carefully explored by Soubeiran (*Annal. de Ch. et Ph.* XLIII. 422.), is one equivalent of arsenic and one of hydrogen.

The *Sesquihydruret*, arsenuretted hydrogen, *Arseniure Trihydrique* of Berzelius, was discovered by Scheele, noticed by Proust, and elaborately examined by Tromsdorf, Stromeyer, Dumas, and Soubeiran. The latter prepared it perfectly pure, by the action of concentrated hydrochloric acid on an alloy of equal parts of arsenic and zinc. The resulting gas, being entirely absorbable by a saturated solution of sulphate of zinc, showed thus its exemption from the presence of free hydrogen, found in all the specimens prepared in any other manner. Dumas found that the purest gas he could produce was intermingled with more than twice its bulk of free hydrogen.

Arsenuretted hydrogen is permanent at all common temperatures, but at — 40 c is condensed into a limpid liquid resembling ether. According to Dumas, its specific gravity is 2.695. It is highly offensive to the smell, and, mixed with air, even in the proportion of one tenth part, rapidly destroys animal life. In smaller proportion, it produces anxiety, lassitude, vertigo, nausea, vomiting, and *excessive constipation.* To the inhalation of this gas, prepared by heating arsenic in an alkaline *lixivium*, science owes the loss of M. Gehlen. Stromeyer and Berzelius thought it insoluble in water, but Soubeiran has shown that water absorbs about one-fifth of its bulk, and that the solution causes precipitates in metallic solutions.

Heated in a glass tube, one volume of the gas, after depositing its arsenic, yields one and a half volumes of hydrogen gas. Two volumes, by complete combustion in three volumes of oxygen, produce one

atom of arsenious acid and three atoms of water. Arsenuretted hydrogen, by inference from these facts, is composed of two atoms of arsenic and three of hydrogen, and two volumes are formed by one of arsenical vapour and three of hydrogen. SOUBEIRAN confirmed this view, by the reaction of arsenuretted hydrogen on the salts of copper and silver.

In solution, the arsenuretted hydrogen is not likely to be used as a poison. Its detection is, however, easy, as its precipitates are of a brownish-black colour in most of the metallic solutions, while it produces no change in alkaline and earthy salts.

Even the $\frac{1}{10,000}$ part of the gas may be detected in a gaseous mixture, by means of a solution of perchloride of mercury. When exposed to arsenuretted hydrogen, a solution of corrosive sublimate is soon covered with a pellicle of arsenious acid and calomel, followed by a metallic coating of amalgam of arsenic, which becomes gradually more and more manifest. When unmixed arsenuretted hydrogen has been thus treated, there remain pure hydrogen and a solution of arsenious acid.

Fluoride of Arsenic is composed, according to DUMAS, of one atom of arsenic and three of fluorine, and has, according to UNVERDORBEN, a specific gravity of 2.73. It is liquid, volatile, colourless, heavier than water, and very poisonous. The least drop causes a painful sensation of burning, excites thick blisters filled with pus, and finally creates ulcers exceedingly difficult to heal.

It is easy to detect this substance by the reaction of water, in which may be found arsenious and hydrofluoric acids.

It is obtained by the distillation of fluor spar, arsenious and sulphuric acids.

The *Chlorides of Arsenic* may, according to BERZELIUS, be formed by distilling arsenic with calomel and corrosive sublimate, forming protochloride and trichloride respectively. DUMAS appears to think that all the suggested processes produce one substance, trichloride, a fuming, volatile, colourless, and very poisonous liquid, heavier than water, and transformed by water into arsenious and muriatic acids. As the best method, he suggests the introduction into a tubulated retort, of arsenious acid with ten times its weight of sulphuric acid, and, at 212° F., the farther introduction of fragments of common salt. The pure chloride may be collected in cooled receivers.

Dr. DAVY esteems as a sesquichloride, the product of the combustion of arsenic in chlorine gas.

The chlorides are easily tested by water, and the detection of the arsenious and muriatic acids formed by it.

Bromide, *Iodide*, and *Seleniuret* of arsenic are producible by the direct union of their constituents. The bromide is a colourless liquid, yielding, by water, arsenious and hydrobromic acids. The iodide is a red crystalline solid, resolved in the same way into arsenious and hydriodic acids.

The *sulphurets* of arsenic are, according to BERZELIUS, not less than five; but as most writers describe only three, and as these alone are accessible to the public, they merit exclusive attention.

Realgar, *red*, or *protosulphuret* of arsenic is found in the mineral kingdom, and is also formed by fusing together one part of sulphur and two of arsenious acid. The mass is semicrystalline, and of a red colour. According to DUMAS and BERZELIUS, it consists of one equivalent of each of its constituents.

Orpiment, *yellow*, or *sesquisulphuret* of arsenic is also found as a mineral. It may be artificially produced by treating a solution of arsenious acid by sulphuretted hydrogen, or by distilling together mixtures of arsenic or arsenious acid with proper proportions of sulphur.

It corresponds in composition with arsenious acid, being formed of two atoms of arsenic and three of sulphur.

Persulphuret of Arsenic is of a citron-yellow colour, and is obtained by precipitation by sulphuretted hydrogen, from a solution of arsenic acid; or, better, by adding an excess of muriatic acid to a mixture of the solutions of an alkaline arseniate, and a sulphuret of potassium or sodium.

Its elements consist of two atoms of arsenic and five of sulphur.

All these sulphurets are insoluble in water or alcohol, but soluble in alkaline solutions and those of alkaline sulphurets. They displace sulphuretted hydrogen from sulphuretted hydrosulphates, and carbonic acid from carbonates and bicarbonates, forming, in consequence of complicated changes, sulphuret of arsenic with bases of alkaline sulphurets. Cold water slowly, and hot water rapidly, decompose the sulphurets, sulphuretted hydrogen and arsenious acid being the result.

They are used in dyeing and painting, and may therefore occasion fatal accidents. Although not very poisonous, be-

cause of their insolubility, Orfila has shown that they are deleterious when taken internally.

They may be readily detected by the characters already given, and by reduction.

The reduction may be effected by mixture with soda, potash, or black flux, and the application of a spirit-lamp to the glass tube which is made to contain them.

We are as yet unacquainted with any compounds of arsenic with azote, carbon, boron, or silicon.

Arsenic combines readily with phosphorus, when equal parts of the constituents are distilled together over a moderate fire. Phosphuret of arsenic is of a brilliant black colour, unaltered by water, in which it is therefore convenient to preserve it. (*Annal. de Chimie.* XIII. 139.)

Two *impure* sulphurets, of a highly poisonous quality, are sold in the shops, under the names of orpiment and king's yellow. The former is an admixture of orpiment and arsenious acid, and the latter, according to Christison, a compound of sulphuret of arsenic, caustic lime, and free sulphur. Guibourt has shown that the former sometimes holds as much as 96 per cent. of the oxide.

King's yellow in solution in water, is not affected by lime-water or sulphuretted hydrogen. Ammoniacal nitrate of silver causes a dirty brown, and ammoniacal sulphate of copper a scanty dirty lemon-yellow precipitate. Its sulphuret may be separated by ammonia, and subsequently thrown down by an acid. Diluted hydrochloric or acetic acid will separate the lime from the free sulphur, and yield it up to oxalate of ammonia or the alkaline carbonates. The free sulphur may then be known by its fusion, combustion, and sulphurous acid-vapour.

Arsenical Alloys are easily formed, and are generally very brittle and fusible. Many of them decompose water, and produce the acids and the hydrurets of arsenic. They are consequently unsafe and unstable compounds, liable to reaction with atmospheric moisture, and to evolution of a poisonous gas when handled. The alloy of arsenic and tin affords the best means of obtaining trihydruret of arsenic. They may be formed by direct union, as exemplified by tin platinum and potassium; by reaction of the bases of the earths and alkalies on arsenuretted hydrogen, or by treating metallic salts by arsenuretted hydrogen.

The Salts of Arsenic, likely to engage the attention of the physician, or medical jurist, are the arsenite and arseniate of the alkalies, particularly those of potash; the pigments of arsenite of silver and arsenite of copper; and the sulpharseniate of the sulpho-base of lime, resorted to as a depilatory.

The *arsenites*, notwithstanding their importance, have not been examined with much care. Those of the alkalies are very soluble in water, make green the vegetable blues, and are not crystallizable. The arsenites of copper and silver are insoluble in water, but soluble in an excess of arsenious acid, and in almost any acid which does not form with their bases insoluble compounds.

Treated with charcoal or black flux, the arsenites yield metallic arsenic, which is either sublimed or retained in the form of an alloy.

The insoluble arsenites yield soluble salts by being boiled with carbonate of potash or soda, in which the poison may be detected by the usual tests.

The soluble arsenites are, if neutral, distinguished by giving a yellow precipitate with nitrate of silver; a green, with sulphate of copper; and a white, with lime-water. *When acidulated* with acetic or muriatic acid, sulphuretted hydrogen throws down orpiment.

The *arseniates*, though not so frequently used, have been more thoroughly examined. These salts resemble in composition those of phosphoric acid, with which they are frequently *isomorphous*. They usually bear a red heat without decomposition, but, when charcoal is present, submit to decomposition, with the evolution of metallic arsenic.

In conducting this experiment on the alkaline arseniates, a strong heat is necessary; but the heat of a spirit-lamp is quite adequate to the subversion of the arseniates of lead, copper, or silver. The insoluble arseniates may be converted into soluble salts, by being boiled in a strong solution of the alkaline carbonates; in which state, if perfectly neutral, they may be tested by nitrate of silver, which will afford a brick-red precipitate; by nitrate of lead, which will throw down white arseniate of lead; and by sulphate of copper, which developes a green precipitate. After removing, by filtration, the cupreous precipitate, the liquid, much reduced by evaporation, gives, by alcohol, according to Chenevix, a *blue* precipitate. Berzelius esteems the first a subsalt, and the latter a neutral one.

In closing the *chemical* part of this article, we may observe that it has been

purposely freed from complication with the medico-legal inquiries. The validity of the various tests, their modification by complex organic mixtures, and the many nice precautions essential to perfect success in the search after arsenic, will be placed in a much stronger light, by being treated of in a separate place. The want of such an arrangement is felt by every one who comes to the subject, without a great deal of antecedent preparation.

The table which closes this section is compiled from Dr. TURNER's last (5th) edition of his work on chemistry.

	Arsenic.				Equiv.	Formulæ.
Arsenious Acid	75.4.	2 eq. + Oxygen	24.	3 eq. =	99.4	$2As + 3O.$ or $\underline{\overset{\cdots}{As}}$
Arsenic Acid	75.4.	2 eq. + Oxygen	40.	5 eq. =	115.4	$2As + 5O.$ or $\underline{\overset{\cdot\cdot\cdot\cdot\cdot}{As}}$
Protochloride	37.7.	1 eq. + Chlorine	35.42.	1 eq. =	73.12	$As + Cl.$ or $AsCl.$
Sesquichloride	75.4.	2 eq. + Chlorine	106.26.	3 eq. =	181.66	$2As + 3Cl.$ or $As^2Cl^3.$
Periodide	75.4.	2 eq. + Iodine	631.5.	5 eq. =	706.9	$2As + 5I.$ or $As^2I^5.$
Sesquibromide	75.4.	2 eq. + Bromine	235.2.	3 eq. =	313.6	$2As + 3Br.$ or $As^2Br^3.$
Protohydruret	37.7.	1 eq. + Hydrogen	1.	1 eq. =	38.7	$As + H.$ or $AsH.$
Arsen. Hydrogen	75.4.	2 eq. + Hydrogen	3.	3 eq. =	78.4	$2As + 3H.$ or $As^2H^3.$
Protosulphuret	37.7.	1 eq. + Sulphur	16.1.	1 eq. =	53.8	$As + S.$ or $AsS.$
Sesquisulphuret	75.4.	2 eq. + Sulphur	48.3.	3 eq. =	123.7	$2As + 3S.$ or $As^2S^3.$
Persulphuret	75.4.	2 eq. + Sulphur	80.5.	5 eq. =	155.9	$2As + 5S.$ or $As^2S^5.$
Triarseniate of Soda	93.9.	3 eq. + 115.4.		1 eq. =	209.3	$3\dot{Na} + \underline{\overset{\cdot\cdot\cdot\cdot\cdot}{As}}.$
Triarsen. of Potash	141.45.	3 eq. + 115.4.		1 eq. =	256.85	$3\dot{K} + \underline{\overset{\cdot\cdot\cdot\cdot\cdot}{As}}.$
Diarseniate of do.	94.3.	2 eq. + 115.4.		1 eq. =	209.7	$2\dot{K} + \underline{\overset{\cdot\cdot\cdot\cdot\cdot}{As}}.$
Arseniate of do.	47.15.	1 eq. + 115.4.		1 eq. =	162.55	$\dot{K} + \underline{\overset{\cdot\cdot\cdot\cdot\cdot}{As}}.$
Triarsen. of Silver	348.	3 eq. + 115.4.		1 eq. =	463.4	$3\dot{Ag} + \underline{\overset{\cdot\cdot\cdot\cdot\cdot}{As}}.$

§ 2. *Toxicological Effects, and Modes of Detection.* In medico-legal investigations into cases of poisoning by arsenic, the chemist is commonly embarrassed by, 1st. the organic matter with which the poison is commingled, and 2d. the very minute quantity preserved in the stomach and bowels after hours of copious vomiting and purging. The former often obscures by discoloration, the precipitates produced by the liquid reagents; or by viscosity, or chemical action, prevents their descent and aggregation. The latter often demands an exquisite skill in manipulation, because a slight loss, or a minute error of process, may prove irremediable.

If possible, in suspected cases, the whole *primæ viæ* should be obtained, and carefully closed by ligatures at the ends, so as to retain their contents. Before opening them, their external appearance should be carefully and minutely noted, and parts apparently most affected, separated from the rest by double ligatures, antecedent to the insertion of the knife or scissors. By the same means, the contents of the stomach, of the duodenum, of the other small intestines, and also of the colon and rectum, should be disparted.

The examination of the *interior* should commence with the *œsophagus*, and should have reference to the morbid appearances, and the detection of minute, but solid pieces of the poison. The former will be treated of in a separate place; the latter are to be sought for first by the eye, assisted, if necessary, by such a lens as is used by watchmakers. Afterwards, the ends of the fingers should be carefully applied to every part of the surface, and with most particularity to those spots which exhibit marks of inflammation or disorganization. Solid particles thus found, should be collected together, and washed in a clean watch-glass with a few drops of cold water, and immediately removed and dried. The liquid used in cleansing them should be carefully preserved for the application of dissolved tests. The solid, placed at the bottom of a dry-test tube, and covered with fresh and dry black-flux, and subjected to the action of a small spirit-lamp flame, will afford, when it consists of arsenic, the metallic ring.

That may be subsequently tested by its odour, when thrown on incandescent charcoal, and by the various precipitates, which a solution of its oxide may be made to present.

The other subdivisions of the *primæ viæ* should be explored in the same patient and careful manner, and, if possible, a still more minute examination should be made of the stomach and its contents. The detection there of solid particles is not unusual, and when made, saves an immense amount of subsequent labour and anxiety.

In the pursuit of this preliminary examination, the contents of each section of intestine should be placed in a proper separate repository, together with the washings of that part, made for a better view of the internal surface. The vessel thus used, should be immediately marked and set aside.

Failing the detection of solid arsenic, a solution of the *contents* of the stomach, if already formed, should be examined; or, if not formed, prepared for examination, in the following manner. If there be found in the stomach a sufficiently thin fluid, it should be filtered; or if too thick for that process, it should be diluted with distilled water, and boiled for at least half an hour, and then filtered. But very frequently the stomach is found nearly empty, and coated within with a viscid substance, which is often so adhesive as to cause the removal of the mucous lining in the attempt to scrape it off. When a quantity of such matter can be separated, with or without the inner coat of the stomach, it should be well boiled in distilled water, and filtered, taking care in this, as *in all cases*, to preserve the filter and its solid contents for farther examination, if that should be found necessary.

When the stomach is entirely empty, or when its contents fail to yield proofs of the existence of the poison sought for, it should be cut into pieces, and boiled in distilled water. Some writers, and among the rest, Berzelius, recommend the addition of a little caustic potash to the water, by which means the solution is more effectual, and the filtration easier. After filtration, various processes have been suggested for the removal of the animal matter, and the precipitation of the arsenic.

Berzelius recommends the following method. Supersaturate the liquid with hydrochloric acid, filter, and transmit a stream of sulphuretted hydrogen gas. If there is arsenic present, a yellow colour is soon observable, and if abundant, the newly-formed sulphuret of arsenic is thrown down. If not copious, there is no precipitation until, by heat, the liquid is concentrated. Although the presence of arsenic will cause these phenomena, the operator is not certainly to infer its existence from such appearances alone, since they *may* be produced by other causes. The solution and precipitate are to be transferred to a small filter, and the filter washed with water until the solid matter has been made as clean as possible. If the quantity of it be too small to be removed from the filter by a penknife, the sulphuret should be washed through it by liquid ammonia, and that driven off by evaporation from a thin watch-glass. The still adhering animal matter is to be destroyed by projecting the result, little by little, into melted nitre at the bottom of a glass tube. The *arseniate of potash* thus formed is dissolved in a few drops, or as small a quantity as possible of water, to which an addition of lime-water in excess is to be made, so as to throw down a precipitate of arseniate of lime. A boiling heat completes the precipitation.

The arseniate of lime, collected on a filter, dried at a *low* red heat, and intimately mixed with fresh burnt charcoal powder, is to be introduced into the bulb of a glass tube of the shape and calibre expressed in the annexed figure.

When the product is large, a straight tube sealed at one end will answer the purpose; and we see no good reason for preferring a tube of the shape recommended by Berzelius, to a straight one of small dimensions, inflated, if necessary, into a bulb at the sealed end. After such a moderate warming as will dispel moisture from the matter and the tube, the bulb is to be heated until the glass begins to melt. The arsenic is thus reduced, and is collected in a characteristic state in the narrow part of the tube.

Berzelius suggests, for the detection of *arsenic acid*, the use of hydrosulphuret of ammonia, instead of sulphuretted hydrogen, which acts imperfectly on that acid. After acidulating, as before, with hydrochloric acid, and filtering, surcharge with hydrosulphuret of ammonia, heat gently for an hour, precipitate by hydro-

chloric acid, collect on a filter, and treat the product as in the case of arsenious acid.

In Germany, the process of Valentine Rose is in current use. His directions are, to boil the suspected matter with potash, filter, boil a second time, and add, by degrees, during ebullition, nitric acid, until the liquid becomes decidedly acid, limpid, and of a bright yellow colour. Filter while hot, and add carbonate of potash, not to complete saturation. Boil to dispel carbonic acid, and add lime-water until a precipitate is formed. The lime first saturates the excess of nitric acid, and then is thrown down with the arsenic as arsenite of lime, along with animal matter and phosphate of lime. The precipitate is to be collected on a filter, washed, dried, and mixed with charcoal and half its weight of powdered vitreous boracic acid. A bright-red heat causes the boracic to supplant the arsenious acid, which is subsequently decomposed by the charcoal. The arsenic is then found just beyond the sphere of the red heat, usually in a bright ring. When in very minute quantity, it merely darkens the tube, but may be made to give a metallic look by rubbing the gray powder on white paper with some hard substance, such as a glass tube. When the paper is burnt, the arsenical smell is observable.

Professor Hare proposes to peroxidize the arsenic, and to destroy animal matter, by boiling the suspected substance to dryness, along with strong nitric acid, redissolving and forming by lime-water, arseniate of lime, and reducing by charcoal and heat. This process has the merit of great simplicity, and is calculated also to discover any possible preparation of arsenic. The learned Professor detected in this manner, in a very complex organic mixture, the arsenic which did not respond to any liquid reagents.

Orfila, who is followed in France, destroys the animal matter with hot nitric acid, neutralizes with potash, adds hydrochloric acid in slight excess, precipitates by a solution of sulphuretted hydrogen and heat; filters, washes through with liquid ammonia, and by neutralizing the ammonia with hydrochloric acid, again throws down the sulphuret, and collects it. Christison finds great fault with him for not pursuing the inquiry farther, but as he has in another place, stated the mode of reducing the sulphuret, and the various methods of recognition of arsenic, the remarks may be deemed hypercritical.

In England, and generally in the United States, the preferred process of reduction is that suggested by Professor Robert Christison, in the second edition of his great work on poisons. It is that, too, to which Dr. Turner has lent his high authority, and which on the whole is best calculated to detect the presence, in organic mixtures, of minute portions of arsenious acid.

"The first step of the process for detecting arsenic in organic fluids, is to procure a transparent solution. For this end, it is sufficient to boil the suspected material for half an hour, distilled water being previously added, if necessary, and any solid matters being cut into small pieces. The coarser solid particles being then separated by a gauze filter, the fluid is to be filtered through paper. In the case of the contents or tissues of the stomach, the filtration is slow, occupying at least thirty-six hours. If greater dispatch is necessary, it is useful to boil with it a little caustic potash, previous to filtering through paper.

"The next step is to free the fluid as much as possible from animal matter, in order to procure subsequently a sulphuret which shall not yield empyreuma when reduced; for animal matter in solution is very apt to be thrown down along with the sulphuret; and a small quantity of animal empyreuma will render the reduction precarious. The removal of animal matter may sometimes be sufficiently accomplished by acetic acid alone, which coagulates casein," (and albumen).

"In order to ascertain whether, after this addition, the fluid is ready for the sulphuretted hydrogen, neutralize it with ammonia or potash, and test a few drops with ammoniacal nitrate of silver, as a trial test. If it gives a characteristic precipitate, the oxide is pretty abundant, the fluid is free enough of animal matter, and the process for converting the arsenic into sulphuret may be proceeded with. If the silver test does not act characteristically, another step will be required for removing the animal matter.

"For this purpose, all that is necessary is to evaporate the solution, at a moderate heat, to dryness, to form a solution anew, by boiling successive portions of distilled water on the residue, and to filter this solution," (after it is cooled).

"The fluid to be subjected to trial, must be neutral, or acidulated with a vegetable acid. If the fluid is alkaline, the sulphuretted hydrogen will not act, because the precipitate it would otherwise form is soluble in the alkalies. If, on the other

hand, a mineral acid, at least nitric or sulphuric acid, be present in excess, an excess of sulphur is thrown down, which would subsequently prevent the process of reduction from succeeding. Hence, if the fluid reddens litmus, and the acid is either unknown, or a mineral acid, it must be neutralized with potash; if it is alkaline, it must be acidulated with acetic acid; and it is well to acidulate with that acid in all cases. Sulphuretted hydrogen has no action on *diluted* acetic acid. The fluid being thus prepared, is to be subjected to a stream of sulphuretted hydrogen gas, for ten or fifteen minutes. The first portions of gas turn the arsenical solution to a bright lemon colour, and the subsequent portions throw down a flocculent precipitate, of a sulphur-yellow tint, which is the sulphuret of arsenic,—the sulphur of the reagent unites with the metal of the oxide, and the hydrogen of the former unites with the oxygen of the latter, to produce water. If the proportion of oxide in solution is small, no precipitate, but only a yellowness or yellow milkiness is caused, owing to the sulphuret being soluble in an excess of sulphuretted hydrogen. An essential step in the process, therefore, is to expel that excess by boiling; upon which a distinct precipitate, and colourless fluid are produced." "If the sulphuret, after boiling, does not subside easily, it is often useful to add a little muriate of ammonia to the fluid; and if the fluid still continues muddy, and the deposition be not complete, it is right to leave it at rest for forty-eight hours or upwards." After the supernatant liquid has been withdrawn, the remainder is poured upon a filter, and when dry enough to admit of it, the filter is to be gently pressed between folds of bibulous paper, so as to fit the mass for removal by a penknife, to a watch-glass, in which it may be dried thoroughly *before* a fire, or over a vapour-bath. When the quantity is very small, and adheres to the filter, it may be washed through with ammonia, precipitated by the cautious addition of hydrochloric acid, and dried on a watch-glass: or it may be transferred to a tube, washed with warm water, suffered to subside, and after drawing off the water, dried by cautiously heating the tube. The reduction is effected by placing the sulphuret in the bottom of a sealed glass tube, and covering it with black flux, or with a mixture of two parts of ignited carbonate of soda and one of recently prepared charcoal powder.

In the introduction of the materials, a glass funnel made of a smaller tube serves to keep the recipient clean. In the absence of that, a good substitute may be made of hot-pressed letter-paper, cut, not torn, and rolled up so as to form a funnel or groove. Any obscuring dust should be wiped out, and care should be taken to remove by bibulous paper, or some cotton affixed to a wire, the moisture which rises when the process of reductive heating is commenced. The upper part of the material should be heated first, and with a very small flame of a spirit-lamp. Afterwards the heat should be applied to the bottom of the tube, the flame having been previously enlarged by raising the wick.

The crust thus obtained may be more fully tested by oxidizing it on Dr. Turner's plan, or by subliming it from burning charcoal and smelling it, or by putting a fragment into a little ammoniated sulphate of copper on a watch-glass, so as to produce, after some time, Scheele's green.

One of the most certain processes for the detection of arsenic in organic mixtures, has been suggested by Mr. Venables, in the 10th volume of the *London Medical Gazette*, p. 118. This process will detect equally well any of the arsenical preparations, and by it, according to its author, there will be procured the greatest possible quantity of the poison.

"Boil the suspected matters with a feebly alkaline solution, filter coarsely, boil with a sufficient quantity of nitric acid to destroy the organic matters, filter, render feebly alkaline by means of caustic potash, add acetic acid in slight excess, filter, and pass through a current of sulphuretted hydrogen, separate the precipitated sulphuret, deflagrate with nitre, dissolve in distilled water, and filter: the addition of nitrate of silver will now precipitate the arseniate of that metal in the form of a brick-red powder, which, on reduction with charcoal and boracic acid, parts with all its arsenic." This process is compounded of parts of those of Rose and Christison, to which Mr. Venables has added the conclusion by the silver test. Though tedious and very complex, it is perhaps the surest mode of getting at very minute quantities of the poison. It is necessary, in attempting to reduce the arsenic acid or its compounds, to urge the spirit-lamp flame by the blow-pipe, as a full red heat is requisite for their complete decomposition.

The quantity of arsenic which may be detected by any one of the preceding processes, is exceedingly minute. Christison thus discovered the twentieth of a grain, and we ourselves formed eight dis-

tinct crusts, in as many tubes, from a single grain of arsenic, deposited for several weeks, in the stomach and intestines of a dead subject.

When by any process of reduction, in a glass tube, the metal is sublimed, the following phenomena are observed. If the heat is slowly applied, there appears at first a white ring of arsenious acid, placed at some distance from the flame. Soon after, the whiteness disappears, and an umber, and finally a jet-black, shining ring replaces it. Nearer to the flame, subsequently appear, a few metallic-looking spangles, which, rapidly increasing, cover the whole surface, and form a bluish-white metallic crust of considerable splendor. The metallic ring is often continuous with the black one, though not unfrequently there is a visible portion of unoccupied glass between them. In some instances, there is only a black ring, and in others, the upper part of the white ring retains its colour to the close of the experiment; so that we may observe in the same tube, a white, a black, and a metallic ring." In a very felicitous experiment, the arsenical ring is exclusively of a metallic lustre, no black and no white crust being apparent.

As in some cases where arsenic is present, we have only a black ring, its true character becomes a subject of interest. It is not a little surprising to find in authors, so few allusions to the black ring, which is so commonly present. SCHEELE mentions in one place, that 'a shining regulus was obtained mixed with a little arsenic and *charcoal dust*.' CHRISTISON says 'whenever the *dark* crust begins to form,' &c. What he means by the 'dark crust' is not stated in that place, but from passages in his papers and those of PARIS and R. PHILLIPS, we may presume that they supposed it to be carbonaceous. PHILLIPS says 'it would save the introduction of *charcoal* into the tube, and prevent it from being mistaken for sublimed arsenic.' CHRISTISON observes (*Edinb. Med. and Surg. Journ.* XXII. 80.), "a black vapour rises, and condenses on the tube. This is *charcoal*," &c. "The arsenic does not begin to sublime till the discharge of carbonaceous vapour has nearly ceased, *and it always condenses lower down.*" PARIS, in his Pharmacologia, maintains a like opinion, and terms the black ring "*a film of very finely divided charcoal.*" BERZELIUS was the first to suspect the true character of the dark ring. He says, in his *Chimie*, "the suboxide is obtained in the reduction of arsenic, for that which sublimes in the first instance is the ***suboxide***, of which very thin coats show, by transmitted light, a brownish colour." When this great author treats of sublimation, in medico-legal questions, he does not even advert to the dark ring, so that a novice in such matters must be inevitably misled by what, on this subject, is termed the highest authority.

The purest metallic arsenic without any charcoal, will often present, when heated in a tube, the three rings. They consist of white oxide, suboxide intermingled with white oxide and metallic arsenic, and a pure metallic substance—the last being nearest to the flame, and the first at the greatest distance.

After describing the totality of these phenomena, CHRISTISON declares that "it may be safely laid down that the appearances exhibited by a well-formed crust are imitated by no substance in nature;" and Professor SILLIMAN says that "the reduction of the arsenic is perfectly decisive, and, if this proof is obtained, there can be no mistake." In a paper on this subject, in the *Amer. Journ. of the Med. Sciences.* X. 126., we have shown that sulphuret of mercury forms, when sublimed, appearances so similar to those by arsenic, that the three rings are often seen of like colours and in similar order. "Even when the quantity used amounted to several grains, the semblance was so strong as to deceive experienced chemists." The experimenter should never rest satisfied, until, having extracted the substance, he perceives its metallic lustre, when rubbed on clean paper, and smells its arsenical odour, as it is thrown up from incandescent charcoal.

The *cinnabar* stains the paper of a vermilion hue, and its odour over burning charcoal is sulphureous. A very scrupulous observer will also oxidize a part, dissolve it in clean water, and use the liquid tests pointed out in the chemical part of our article.

Although in *simple* solutions, the liquid tests afford unimpeachable evidence, yet in organic mixtures, *they are scarcely entitled to the slightest attention*. In no one of the cases of poisoning examined in this city, has the poison been rendered satisfactorily evident by liquid tests. In five judicial cases in which Professor CHRISTISON had to search for arsenic, neither ammoniacal nitrate of silver, nor sulphate of copper, gave indications of its presence, although unequivocally detected by the process of reduction by the aid of sulphuretted hydrogen.

The impediments are of two kinds. Some substances, not poisonous, afford precipitates like those produced by arsenic; while others prevent the arsenic, even when present, from being thrown down. Thus, decoctions of crude coffee and of onions, cause greenish precipitates with sulphate of copper; and alkaline phosphates react on the nitrate of silver so as to produce a yellow precipitate. Several substances separate the sulphur from sulphuretted hydrogen, and indeed such a separation is sometimes spontaneous. To render the liquid tests, therefore, available in such cases, a great variety of precautions has been suggested. It has been proposed by ORFILA to decolorize with chlorine, and by PHILLIPS, with animal charcoal. MARCET got rid of chloride of sodium by adding a little nitric acid and cautiously precipitating with lunar caustic; and CHRISTISON suggests the removal of casein and albumen by acetic acid. But it must appear obvious to any one acquainted with the subject, that most of these processes endanger the loss of a portion of the arsenic, and that the substances most likely to interfere with a conclusive manifestation of the presence of the poison, are not separable by the indicated means. For the unprofitable discussion of this subject, the curious reader is referred to the works on Medical Jurisprudence.

It may not, however, be useless to state that the reaction of the alkaline phosphates, and of arsenic, with nitrate of silver, may be discriminated, by making the experiments with a few drops, on white paper. The colour, at first nearly the same in both, remains for some time unchanged in the case of the arsenic, but it gradually becomes brown and continues so when dry. The phosphate, in less than two minutes, fades into a 'sad green,' becomes darker and darker, and finally quite black. The precipitate with arsenic is flocculent, while that by the phosphate is of a homogeneous liquidity.

Arsenite of Copper is detected in organic mixtures, by solution, by means of acetic acid and heat, filtration, and precipitation by sulphuretted hydrogen. The sulphurets of copper and arsenic are separable by ammonia, which dissolves only the latter; and that is recoverable by hydrochloric acid.

Arsenite and Arseniate of Potash are separated from organic compounds, by the same means as have been selected for the detection of arsenious acid.

The *Sulphurets of Arsenic*, being insoluble in most organic mixtures, may be found not unfrequently in visible particles in the contents of the stomach. If in a too finely divided state to be collected by mechanical means, they may be dissolved in an excess of ammonia, filtered, and precipitated by hydrochloric acid.

The *poisonous power of the preparations of arsenic* is probably in direct proportion to their solubility, modified by their tendency to pass into other and more soluble forms. Thus, regulus of arsenic, not itself deleterious, is so soon converted into soluble oxides, as to seem noxious. In the same way, sulphuret of arsenic was found by GUIBOURT to have no injurious effects, whilst ORFILA caused by it the death of various animals, and that in some cases even by application to external wounds. DECOURDEMAUCHE reconciles these apparent contradictions by showing that in simple water, but more readily in organic mixtures, the sulphurets react on the elements of water, and form oxides of arsenic and sulphuretted hydrogen. The only truly innoxious compounds of arsenic hitherto tried are arsenuret of tin, given by BAYEN and DEYEUX, and a native sulphuret of iron and arsenic (mispickel), administered by RENAULT. Arsenuretted hydrogen so diffusive and soluble, is, when inhaled, the most poisonous compound of arsenic. Next to it may be placed arsenic acid and soluble arseniates, arsenious acid and the soluble arsenites.

It is not easy to determine *the amount of any poison capable of causing death*; as so much must depend on the subject, as well as the circumstances under which administered. The smallest dose of the *arsenious acid*, known to have produced death, was a solution of four and a half grains, taken by a child four years old. Estimating the amount necessarily destructive to an adult, by the usual rules for the proportional administration of remedies to children and adults, a full-grown individual should perish under the effects of from 20 to 30 grains. Accordingly, the smallest dose actually known to have killed an adult was 30 grains. HAHNEMANN alleges that four grains will kill within 24 hours, and that even two grains may destroy life in a longer period. RENAULT killed a large dog by means of one grain; and severe symptoms have been excited in human subjects by doses varying from one half to one grain. Of the less soluble compounds, much greater doses are requisite to the destruction of life. Thus OR-

Orfila caused the death of dogs by doses of the *sulphurets* varying from 40 to 70 grains.

The *symptoms produced by poisonous doses of arsenic*, usually begin to show themselves in from half an hour to an hour, although cases have occurred in which they have appeared almost immediately; as on taking a second cup of poisoned coffee, or before finishing the soup; and others in which several hours, nay, a whole night, have intervened between the reception of the drug, and the development of the symptoms. In general, the speediest effects are produced on empty stomachs, and the slowest on those filled with food, or holding some anodyne medicine. The quiescent state of sleep seems to make a singular resistance to the action of this poison. Mr. Edwards (*Lond. Med. and Phys. Journ.* XLIX. 117.) gives a case where the symptoms were manifest in eight minutes: Bernt mentions that a solution of arseniate of potash produced violent affections in fifteen minutes. Christison's case commenced in twenty minutes. Mr. Macauly of Leicester, quoted by Christison, had a patient who took seven drachms of the poison at 8 P. M., went to bed at half-past 9, and *slept* until 11: M. Devergie states a case of poisoning by the sulphuret, where the symptoms did not begin for three hours, and where *sleep* intervened; and Orfila has noticed an instance of the absence of symptoms for five hours. The girl, Warden (*Ed. Med. and Surg. Journ.* XXVII. 450.), took a white powder at ten P. M., went to bed and *slept* until six next morning, and then began to exhibit symptoms of poisoning. Marianne Warwick (*Lond. Med. Journ.* 1830.) took, about 12 o'clock, M., three ounces of laudanum and nearly two drachms of arsenic, yet "even to the hour of her death, excepting pain in the bowels, complained of once or twice, above seven hours after the poison had been taken, there was no symptom of poisoning by arsenic." Death, in this case, arose from laudanum; although, notwithstanding the immense dose, four hours elapsed before any signs of narcotic influence became decidedly apparent. In the case of Kesler's wife, quoted by Dr. Beck, opium and arsenic appear to have been given either simultaneously or alternately; and although a considerable quantity of opium was, after death, found in her stomach, the fatal issue seems to have been caused exclusively by arsenic. The opium appears to have produced occasional drowsiness, and to have retarded the action of the arsenic.

The *duration of life* after taking a fatal dose of arsenic, is as various as the period which elapses before the manifestation of the symptoms of poisoning. Mr. Brodie killed a dog in fifty minutes, by injecting a solution of arsenious acid into its stomach. The effects were narcotic. The shortest recorded case of death by arsenic, is one related by Pyl, in which the poison proved fatal in three hours. Death from arsenic has happened after $3\frac{1}{2}$, 4, 5, 6, &c. hours—most commonly, in from 24 hours to two or three days; and in a few instances, patients have died after an ineffectual struggle of weeks or even months. When death is suddenly produced, the symptoms are either those of a narcotized system, or, much more commonly, such as indicate great disorder of the circulation. When death is caused after a day or two, the signs of irritation or inflammation of the *primæ viæ* are usually most prominent; and when the fatal issue is greatly prolonged, the patient suffers most from affections of the great nervous masses, manifested by tremors, paralysis, convulsions, &c. There is, however, so little uniformity in the action of arsenic, that cases may be cited in which the nervous symptoms presented themselves in the most acute attacks, and where violent indications of inflammation were present, when the subjects survived only five or six hours. It is therefore possible to meet with all the great symptoms of the various stages, in one case, and at one time.

The *ordinary symptoms of arsenical impression* are, at first, a sense of weight and oppression about the *præcordia*. Then ensues, a fiery pain at the stomach, with nausea, vomiting, and faintness. The pain is increased by pressure, and there is sometimes either diarrhœa or tenesmus, with the occasional evacuation of bloody mucus. Not unfrequently, hoarseness and difficulty of speech are observed, and such a degree of dryness and heat in the throat, as to cause a sense of suffocation, and a shortness of breath. When the lower bowels are much affected, there is excoriation of the anus, and the urinary and genital organs are sometimes also attacked. After a time, tremors and twitches, with spasms of the arms and legs, increase the sufferings of the patient. In general, the circulation is very hurried, irregular, and feeble, attended with coldness, clammy sweats, and even lividness of the remote

extremities. In such cases, death occurs in from one to three days.

When the fatal period is prolonged beyond one day, there is frequently a remission of nearly all the symptoms; but after a deceitful calm, the disease recurs with increased violence. Should death be postponed to a still later period, the signs of nervous disorder become more conspicuous. Every stage of irritation may ensue, from the most violent convulsions to entire paralysis. Local palsy is perhaps more frequent than any other indirect effect of arsenic. Lively pictures are presented by different cases, of hysteria, epilepsy, trismus. Sometimes the cutaneous capillaries are engorged, and the surface becomes tumefied, more particularly in loosely constructed parts, such as the eyelids and scrotum, and there occasionally ensues a desquamation of the cuticle. At other times, the blood flows inwards, and a cold, shrunken, livid surface, marks the approach of collapse. The moral state varies from a perfectly collected condition, to that of delirium, or coma.

The peculiarities which frequently attend arsenicated subjects, are curiously varied. In some cases, there is, from beginning to end, an entire exemption from pain. In others, nausea and vomiting are not observed. In a few cases, narcotic effects have almost immediately followed the administration of the poison, while in the greater number, the faculties of the mind are obscured solely by the progress of physical dissolution, and are sometimes unimpaired up to the act of death.' Although the pulse is commonly hurried, one or two cases are recorded in which it became preternaturally slow. JAEGER saw a girl 12 years old who died by drinking water which had stood on the black oxide of arsenic. She made no complaint of pain, even when asked about it, although she retained her senses to the last, knew the persons around her, and spontaneously expressed her wants. Dr. YELLOLY also records a case (*Ed. Med. and Surg. Journ.* V. 389.) of a boy 16 years of age, who died by poison, perfectly collected, without any tenderness of the abdomen, and without pain either in the stomach or bowels. In Philadelphia, five persons simultaneously poisoned by arsenic, were, all of them, exempted from pain in the stomach and bowels. Two out of the five died, and the fatal cases were not affected with vomiting, neither could they be made to reject the contents of the stomach by any of the ordinary means. In the *London Med. and Phys. Journal*, XXXIV, there is related a case where death ensued in about five hours, without vomiting, even although emetics were given.

Cases exemplifying almost every irregularity of the circulatory, digestive, and nervous systems, and a singular variety of disorder of the urinary, genital, muscular, and moral functions, might be cited, but that would unnecessarily extend an essentially prolonged paper. The medical jurist will now be sufficiently on his guard, and must feel convinced that while he recognizes as arsenical, a certain set of symptoms, he will not infer the absence of the poison, because these symptoms are wanting; nor will he decide against its presence in the system, solely because a totally opposite condition may be presented by the patient. It seldom, however, happens that arsenic produces such a *series* of phenomena as may be ascribed to any known disease; and a well-educated physician could, in our day, hardly fail to have his suspicions awakened by the symptoms of the whole case, however anomalous these symptoms might be. Only the cold plague (congestive fever) of our south-western country, the epidemic cholera, and yellow fever, ever present a combination of phenomena such as might be produced by arsenic. But they are epidemics; and they have all of them additional peculiarities which enable a discerning physician to recognize them, or they resemble the arsenicated cases only in a part of their course. We may, after poison, observe the burning pain, and flocculent vomit of yellow fever; but the latter presents the yellow skin, in fatal cases, while the former, in such instances, is almost uniformly accompanied by pain and spasm of the extremities. In the poison case, too, the intestinal evacuations, compared with those of yellow fever, are very distinctive. In those violent cases resembling cold plague, the arsenical case terminates much more rapidly, is accompanied with less cerebral irritation, and more irregularity of circulation, and is very seldom without a distinctive condition of the stomach and intestines. It is, however, with Asiatic cholera, that violent arsenical poisoning is most likely to be confounded. The suddenness of the attack, the pain, spasms, nausea, vomiting, collapse, and speedy death, are circumstances of both diseases; but the extreme lividness of fatal cases of cholera, together with their farina-like evacuations, and the absence commonly, of bloody effusions, may generally serve fully to discriminate them. When the poison-case is protracted, and exhibits both

the inflammatory and nervous stages, the distinguishing marks become so numerous and characteristic as to leave not much doubt of their origination. Still, however distinctive may be the signs of such a case, no man who regards as he should do, the uncertainty and imperfection of human knowledge, will suffer them to *convince* him of the existence of a poisonous cause. Their only legitimate effect should be to arouse his attention, excite his suspicions, and lead him to a fuller and more critical examination of all the evidence that the case has given, or may be made to give.

Under such circumstances, he will endeavour to procure all the remains of the medicine and food, collect the evacuations from the stomach and bowels, and carefully but unobtrusively investigate the probable motives for, and effects of, the destruction of his patient. But a still more important duty consists in a careful *autopsy*, with a view to the observation of the internal changes, and the collection of the materials for chemical investigation. In the most acute cases, the observable effects, if any, are usually confined to the distribution and condition of the blood. In the more ordinary instances, the organic lesions are mainly discoverable in the gastro-intestinal surface; and in very protracted examples, signs may be found of the alteration of the structure of the brain and spinal marrow.

Post-mortem appearances. As in very acute cases of poisoning, the blood is often found dark and liquid, the dependent parts of the body must frequently present accumulations of that fluid. For the same reason, *petechiæ* have been observed in less dependent places, both on the external surface and that of the inner face of the hollow viscera. The heart has been found filled with black fluid blood generally mixed with some flocculi, and, as might be expected, the great veins especially of the abdomen were constantly turgid with black blood. The internal face of the blood-vessels and heart are seldom found altered in hue or structure. Rarely, spots of a sanguine colour may be seen. In a case examined by Orfila, the cavities of the left side of the heart had a mottled hue, and the ventricles displayed crimson spots which extended into the muscular tissue. Godard makes a similar observation, and Orfila observed the same phenomena in animals. As these appearances are not always seen after death from arsenic, and may be produced by many other causes, they ought to have weight only when combined with other testimony. In a very few cases, the blood coagulates, and exhibits an arterial hue. The alteration in the state and distribution of the blood is most observable in those very acute cases in which no organic lesions are discoverable, and where death seems to be produced solely by the destruction of the function of circulation, and its necessary consequences. But the same disorder of the blood and its canals is observable in less rapid cases. The lungs are sometimes found highly congested. In other cases they appear perfectly natural. Jaeger observed extravasated blood in the lungs in certain cases, but never found it out of its proper vessels, in any other organ. Blood has been seen by others, in almost every hollow viscus, and also interstitially deposited, in various places, especially between the different coats of the stomach and intestines.

The *congestion and inflammation caused by arsenic*, wherever applied, whether externally or internally, are most frequently and most extensively found along the course of the alimentary canal. According to Jaeger, the stomach and rectum suffer most; but in the latter position he is not sustained by other authority. As might naturally be expected, the stomach is, in cases of internal poisoning, the most manifest seat of inflammation, and next to that, the small intestines. It is chiefly in cases protracted, or in those destroyed by repetitions of the poison, that the large intestines exhibit the inflammatory phenomena. But in this, as in all other respects, arsenicated patients are subject to no well-defined rule. When arsenic has caused death even by external application, the alimentary canal has exhibited the severest proofs of its action, and in such cases the stomach and small intestines have been chiefly affected. The inflammation is manifested in various degrees. A slight blush is all that is sometimes perceptible. In other cases is displayed every shade of colour, from a bright scarlet to melanotic blackness, with every state of the mucous coat, from thickening and hardening or softening, to the attenuation and even entire removal of parts of it. In a very few cases, holes have been made, through all the alimentary coats. Whenever these apertures are produced by poison, they are surrounded by marks of inflammation; whilst the erosions which are caused after death by any solvent,

such as the gastric juice, are unaccompanied by sanguineous discoloration, or increased vascularity.

As there are no changes of structure peculiarly effected by arsenic, it seems scarcely necessary to enter into a minute detail of the morbid phenomena observed in various instances. As they are always the result, not of the direct action of the mineral, but of the inflammation created by it, the same effects may be traced to *phlogosis* excited by any other active cause. *Possibly* there may arise peculiarity of appearance from the commingling of irritation and diminished vitality in a part. When arsenic excites generally the vascular power of the gastric surface, and suddenly reduces the energy of vitality in the parts with which it comes into more immediate contact, we might expect to find such parts discoloured by dark blood, or elevated by its effusion. In a case of poisoning by corrosive sublimate, these patches of blackness were observed by us where the poison was collected in the greatest quantity. Christison makes the following observations on such phenomena, which he says "there is strong reason to believe, always indicate some violent irritation at least, *if not even irritation from poison only*, in the organ where it is found. It is the effusion under the villous coat of the stomach, and incorporation with its substance, of dark brownish black, or, as it were, charred blood; which is thus altered either by the chemical action of the poison, or by a vital process. In many cases of poisoning with the mineral acids, oxalic acid, arsenic, corrosive sublimate, and the like, there are found on the villous coat of the stomach, little knots, and larger irregular patches and streaks, not of a reddish brown, reddish black, or violaceous hue, like pseudo-morbid redness, but *dark-grayish*-black, or brownish-black, like the colour of coal or melanosis, accompanied, too, with elevation of the membrane, frequently with abrasion on the middle of the patches, and surrounded by vascularity. This conjunction of appearances, I have never seen in the stomach, unless it had been violently irritated; and several experienced pathologists of my acquaintance agree with me in this statement. It bears a pretty close resemblance to melanosis of the stomach; but is distinguished by the melanotic blackness being arranged in regular abruptly-defined spots, and still better by melanosis not being preceded by symptoms of irritation in the stomach. I must express my doubts whether the appearances (in the stomach) now described, ever arise in this country from natural disease. In the *intestines*, they are sufficiently familiar to the physician, as arising from idiopathic enteritis, and from dysentery. But in the stomach, their existence, as the effect of natural disease, is doubtful." 2d ed. p. 120.

The assertion, limitation, and partial retraction of opinion, in the foregoing paragraph, show how impossible is the certain discrimination of the effects of arsenic from those of disease. Each writer, in his turn, condemns the distinctive marks assumed by his predecessors, and himself selects new ones, subject, by his own authority, to so many exceptions and corrections, as to render them practically useless. All that can be safely said is, that when, in the absence of epidemic cholera, cold plague, or yellow fever, there arise, without apparent cause, symptoms of great irritation of the alimentary canal, followed by death, and the exhibition of inflammatory marks in the stomach, small intestines, and rectum, *especially such as are pointed out in the paragraph quoted*, the physician should feel bound to go into a *private* examination of the poison-question; but not without other collateral, or still more direct proofs of poison, venture to raise public suspicion. While from a timid, ignorant, or culpable course, on his part, wrong may have been permitted to go unquestioned, much more frequently character, nay, sometimes life, has been sacrificed to ill-judged and unjust charges of crime. It is always best to call in a confidential medical friend, and candidly discuss with him the grounds of suspicion, and determine, rather on a survey of the whole question, than on a partial and ill-instructed investigation.

Although in general the detection of the poison itself, as well as the evidence of such a death as such a poison would produce, are essential to the verdict of "death by poison," yet cases do occur in which the discovery of poison in the body, or after its ejection from it, is not necessary to such a conclusion. Along with the symptoms, and *post-mortem* phenomena, there may coexist such motives and such conduct on the part of others, as to make a public examination obligatory, even when no poison can be detected. Such circumstances existed in the case which led to the trial of *Lucretia Chapman* and *Espos Y. Mina*, for the murder of the Rev. William Chapman. In that case, the motives for the deed were previously avowed, the symptoms were such as arsenic might produce, the funeral was

hastily made, and the parties implicated in the charge were married in nine days after the death of the husband of one of them. During the illness of Chapman, there was shown an unwillingness to send for medical aid, and a neglect of medical orders when given. In an intercepted letter from Mrs. C., expressions of a mysterious character led to suspicion on the part of the public authorities of the city of Philadelphia, which on inquiry was strengthened by the voice of the neighbourhood. The disinterred body afforded corroborative testimony, and although no arsenic was found, the peculiar odour of that substance was made apparent. *On the whole chain* of events, the medical witnesses founded a declaration of belief in a poisonous cause of death, and that poison arsenic. That opinion was farther confirmed by the discovery that *Mina*, one of the suspected parties, had purchased a large quantity of arsenic, on the very day before the illness of Mr. Chapman. That illness came on suddenly after eating of customary food, of which no other part of the family partook.

The case of Abraham Kesler (Beck's *Med. Jur.*) was also circumstantial, and the conviction obtained, without the demonstration of the presence of arsenic. Its presence was rendered probable by the concurrence of the evidence of various experiments, though none of them conclusively proved its existence. In such cases, the physicians are bound to pursue the subject to the confirmation or refutation of the suspicions naturally created by the obvious phenomena.

Medical jurists have agitated the question of the evidence of the introduction of *poison after death*, with a view to the inculpation of innocent persons, or the accomplishment of some other criminal design. Orfila alleges the existence of such attempts, but cites no particulars.

In such cases, the mucous membrane is altered solely where the poison comes into actual contact with it, so as to create *abrupt and well-defined marks*. These are of a bright red colour, with a dark extravasation here and there when the poison is arsenic, and that applied immediately after death. When the application is made twenty-four hours after death, the spots are of a dark colour. Such appearances were produced by Orfila when he injected arsenic into the rectum. They are, he thinks, readily distinguished from the diffusive irregular inflammation created during life, which, instead of being abruptly defined, is gradually merged in the healthy structure around it.

The suspicion of death by poison is not always felt immediately on the demise of a person whose case may be made long afterwards the subject of legal investigation. The secret thoughts of the attendants reach slowly the knowledge of the proper authorities; and in some instances, the attention of the law is directed to the case by the course of subsequent events. It then becomes necessary to disinter the body.

The *preservative effects of arsenic* have been made the subject of many experiments and much observation. On the whole, the evidence is at present rather in favour of the affirmative, although a good set of comparative experiments is yet wanting to decide fully the merits of a point highly important to society. The German toxicologists, with whom originated the idea of a *peculiar* antiseptic power in arsenic, are almost all of them disposed to consider the opinion in its favour as settled. The medical *Inspector* at Berlin, Dr. Welper, in 1803, first directed public attention to this subject. Two bodies, supposed to have been poisoned, were disinterred after periods of half a year, and two years and a half, respectively, and were found by him to be not putrid, but *dried up*, with here and there gangrenous-looking specks on the inner surface of the stomach. In these cases, arsenic was not found. His friend, Dr. Klanck, pursued the subject by making a number of experiments on animals, which resulted in the declaration, that arsenic, given internally, preserved not only the surfaces with which it came in contact, but the whole animal frame. Many of the bodies continued dry and without decay, after the lapse of three years. The facts on this question, next in order of time, are those at Bayreuth in Bavaria, where poisoned bodies disinterred after five, six, and fourteen months, were found not decayed, but hard. In two cases, the stomach and intestines were so firm as to permit all the usual treatment of a strict mechanical investigation. In one only of these cases, arsenic was not detected.

Dr. Kelch, in Hufeland's *Journal*, mentions the curious preservation of the stomach and intestines of a poisoned human subject, for five months after interment, although the body itself had begun to putrefy before burial. They preserved all their colour, lustre, and consistency. *They had a peculiar smell.* A great num-

ber of cases might be cited, most of them confirmatory of the antiseptic powers of arsenic. For these, the curious inquirer is referred to the works on medical jurisprudence and toxicology, particularly to that of CHRISTISON.

Kesler's wife (BECK) was disinterred two months after her decease. "Putrefaction was far advanced, and the surface of the body was of a dark colour, particularly on the abdomen. The stomach and intestines were in a highly inflamed state," &c. In this case, no notice is taken directly, of the state of preservation of the stomach; but as the appearances produced by inflammation were cognizable, it is to be supposed that they had not participated in the general putrefaction.

William Chapman, whose case has been already alluded to, was interred on the 23d of June, and disinterred on the 23d of September. Before his interment, and almost immediately after death, a putrefactive smell was observed by some of the attendants; but when taken out of the ground, after a lapse of three months, although the face was black and putrid, the abdomen and chest were of a pale white appearance, and resisted the knife so much as to attract Dr. HOPKINSON's particular attention. "No offensive odour escaped from the abdomen." The intestines seemed disposed rather to *become dry* than to putrefy.

Clara Ann Smith, poisoned by commercial orpiment, at Bristol, England, on the 23d of October, 1833, was disinhumed on the 24th December, 1834, fourteen months afterwards. This body, like that of Mr. Chapman, had sustained the greatest change on the anterior part of the head. "The eyes were sunk in, and the lower part of the nose and lips had fallen. The pharynx, tongue and surrounding parts, were much decomposed." The teguments of the thorax and abdomen were converted into adipocire. The diaphragm was extremely firm, the heart much shrunk, the lungs shrivelled and reduced to the size of a man's hand, the stomach and intestines almost empty and flat, and all these viscera were as little altered as "in a person who had died a few days before in cold weather."

The writer of this article put a grain of arsenious acid combined with potash, into the stomach and part of the intestines of a man, who died at the Philadelphia Almshouse. These viscera were exposed for nearly three months to the air of the laboratory, did not putrefy in that time, became much drier, and gave out an odour exactly like that of William Chapman's stomach. It was nearly identical with the smell of dried red herrings.

The number of examples of the preservation of the poisoned organs, is quite sufficient to show that arsenic possesses high antiseptic qualities; and the naturalist, who has long been aware of the fact, avails himself of it to secure his dry preparations. But there is also at least some ground for believing, that this singular mineral exerts, although less potently, a protecting influence over even remote parts of a body which has been destroyed by it. We can explain this solely by supposing the production of arsenuretted hydrogen, and its penetration into the solid tissues. This is rendered probable by the fact that putrefaction usually makes a beginning soon after death, but is subsequently arrested.

A few examples of accelerated decomposition in well-established cases of death by means of arsenic, do not invalidate the general truth. They only serve to put the inquirer on his guard, and to show, that in this particular, as in all others, arsenic is subject to no certain rule of action.

Every part of the body admits the poisonous influence of arsenic. By the nose, rectum, vagina, cuticle of the scalp, wounds and abrasions of other parts of the surface, the deadly energy of this drug has found access to the sources of life. But its apparent effects have usually been in all cases alike, and its manifestations have been chiefly observed in the alimentary canal.

Death was produced in a young man who treated an itchy eruption with an arsenical ointment. (LUSITANUS.) A girl was killed by applying a similar preparation to psoriasis. (WEPFER.) ZITTMAN reports the death of two children by an arsenical solution applied to the scalp. Many cases of destruction by arsenic applied to ulcers, and a much greater number of hurtless applications of the same kind, are quoted by authors. Two causes are assigned for this discrepancy. BLACKADDER found that a large quantity produced no injury; and supposed therefore that it acted so powerfully as to destroy the function in the part, by which a lesser quantity might be introduced into the system. HARLES supposes the difference to be dependent on the integrity of the bloodvessels of the part, and that the danger is always great when there are patulous veins on the part.

FODERÉ relates a case of rectal poisoning; and in ANSIAULX, and in HENKE'S

Zeitschrift, &c., two instances are quoted of the destruction of life by the introduction of arsenic into the *vagina.*

The skin of the lower animals is less easily affected by arsenic than that of the human species. Hence Jaeger thought that this poison did not operate through sound integuments, and Renault denied its power of doing more than to form an eschar, or a pustular eruption. But a number of persons in Germany were severely affected by using arsenic by mistake for hair-powder, and one of them died. A case of a remarkably *arsenical* character is related by Desgranges, in which a woman used, for the extirpation of *lice*, an ointment made of lard and arsenic. She had erysipelas of the scalp, inflammation of the eyes, and enlargement of the neighbouring salivary and lymphatic glands. But, what must greatly interest the toxicologist, she suffered from fever, delirium, vertigo, syncope, pain in the epigastrium, nausea and vomiting, tenesmus, irritation of the genito-urinal organs, and tremors of the extremities.

The *Treatment* of cases produced by the poison of arsenic, must, from the variety of its action, be greatly diversified. The first care of the physician, should be the elimination, as far as possible, of the morbific cause. Emetics have been selected chiefly for their celerity of action, and therefore mustard and water, hot salt water, solutions of sulphate of copper or zinc, ipecacuanha, and the stomach-pump, have been preferred. Unless, however, the poison has, as rarely happens, been given in solution, the greater part will remain in the stomach, and resist every proper effort for its removal.

This fact makes the discovery of an *antidote* highly desirable. Three classes of antidotes have been suggested. One, the viscid, oily, or mucilaginous substances, which are supposed to envelope the arsenical particles, and obtund, or entirely prevent their poisonous action. When these are swallowed almost instantly, they may do good; for it has been often observed that such substances, or, indeed, ordinary articles of food, taken along with arsenic, greatly impede its action. They are usually given, however, too late, and if relied on, do injury by excluding or interrupting the action of better means of cure. Of the demulcents, milk is generally preferred, although gum-water, or any mucilage, will be found nearly if not quite as efficacious. The oils do injury by protecting the arsenic from the action of the chemical agents to be presently noticed, and are thought by some authors to augment the poisonous power of the arsenic.

The second class of counteractives consists of substances chemically inactive as respects arsenic, but which have at various times possessed some reputation as antidotes. The chief of these are magnesia and charcoal, both of which are, at present, very properly disregarded.

The substances which render less active, or entirely inactive, the more poisonous compounds of arsenic, are more to be relied on. As arsenites of the alkalies are believed to be less active than arsenious acid, alkaline solutions have been used remedially. For the same reason, sulphuret of potash, lime-water, and sulphuretted hydrogen, have been recommended, with a view to the production of insoluble compounds of arsenic. We have already seen that these compounds are fatal. Of late, hydrated peroxide of iron has been confidently appealed to for the production of a perfectly insoluble and totally inert arsenite of iron. Drs. Bunsen and Berthold, of Gottingen, who suggested this counteractive, make it, by adding nitric acid to a heated solution of protosulphate of iron, precipitating by an excess of ammonia, and washing the precipitated oxide. The cases cited by the discoverers, as well as those by Soubeiran and others, eminent in this department of medicine, were apparently conclusive on the side of the antidote. Very recently (*Journ. Hebdom. des Progrès*, &c., for March, 1835.), M. Bouley, Jr. presented to the French Academy of Medicine, an essay on this subject. From numerous experiments made on horses, the author believes himself entitled to assert, that when a sufficient quantity of hydrated peroxide of iron is given along with arsenious acid, the poisonous effects are entirely suppressed; that some benefit results from its use even four hours after the reception of the poison, and that, at a later period, it ceases to exert any beneficial agency. He also discovered that neither the oxide, nor the sulphate of iron, could control the poisonous action of arseniate of potash. M. Bouley insists much on the necessity of administering the ferruginous counteractive in large doses.

Indeed, the substances supposed to lessen in any way the activity of the poison, should be given in large doses, and administered as well by the *rectum* as the mouth. When applied per anum, they should be thrown as high into the intestinal canal as possible, by means of a long elastic tube at-

tached to the *apparatus*. If arsenic is liable to be absorbed, the use of these agents will be greatest at the earliest period. At a later hour, they may not find access to the absorbed part of the poison; but they will beneficially alter that which is left in the stomach and intestines.

After the evacuation or transformation of the poison, or even while measures for these ends are in progress, the physician may be required to sustain the patient under the depressing action on the circulation, or the irritation of the great nervous centres, or to allay the inflammation of the gastro-intestinal surface. Not unfrequently, the prostration and inflammation are so coincident as greatly to embarrass the practitioner by the contra-indications. Or the expectation of the inflammatory stage, will restrain him in the use of internal stimulants, during the antecedent threat of collapse. In either case, it must appear proper to prefer external incitants, or such as have no great power of creating gastric irritation. Sinapisms, fomentations, and frictions, combined, *if necessary*, with wine whey, or camphor, or opium, are solely admissible. Blisters, at least when large, increase the mucous inflammations. In the greatest emergency, the depression must be met by more decided stimulants; but the assistant must never forget that the preparations of a less soluble character are, some of them, dissolved by ammonia, which is therefore to be excluded from practice in such cases.

Most commonly, the more urgent symptoms are those of inflammation of the gastro-intestinal surface. Cold demulcents internally, and leeches and revulsive fomentations externally, are chiefly indicated, after the appearance of inflammation. The nausea may be palliated by lime-water and milk; the diarrhœa, by anodyne and mucilaginous injections; and the pain, by anodyne frictions to the spine. In the cases showing a cephalic determination, the opiates will be of course avoided. On the whole, the treatment of the inflammatory effects of arsenic is the same as that for cholera, gastritis, and severe diarrhœa, to which articles the reader is referred, for a fuller view of the management. Under the heads of *Meningitis*, *Apoplexy*, &c., he will find the means indicated for the cure of those cases of poisoning which show cephalic symptoms.

Opium has been sometimes taken along with arsenic, and has always either overcome or postponed the arsenical influence. In these instances, the opium acted as a feeble narcotic, being apparently reduced in potency by the arsenical power. How far it may be safely applied as a counteractive of the irritant and depressing powers of arsenic, or a reductive of its actual effects, remains yet to be investigated.

SUMMARY. 1. Care should be taken to secure as much as possible of the materials to be examined.

2. A strict method is to be observed in conducting the investigation, and nothing, if possible, left to inference, or intrusted to memory.

3. The chemical investigation should be directed at first to the contents of the stomach, failing which, to those of the intestines; and if fruitless, to the tissues themselves.

4. The best process for the detection of minute portions of arsenic, is that of VENABLES; which is compounded of parts of those of ROSE, BERZELIUS, and CHRISTISON, with an original conclusion, by precipitating an arseniate of silver, from a solution of arseniate of potash, by the nitrate of silver, and reducing that by dry charcoal and boracic acid.

5. In cases of actual poisoning, very seldom are the liquid means of detection successfully resorted to, until simple solutions are made, by oxidizing the reduced metal, and redissolving that in pure water. A very critical observer may choose to take the additional trouble.

6. The organic mixtures prevent success through liquid processes, by colouring the precipitates deceptively, by preventing precipitation, by affording precipitates not arsenical, but of an arsenical appearance, and by causing losses which may defeat the detection by reduction.

7. The preparations of arsenic are hurtful, nearly, if not exactly, in proportion to their solubility, added to their facility of conversion into more soluble compounds. Arsenic acid and the soluble arseniates, arsenious acid and its soluble compounds, are the most active agents of destruction. Common orpiment is highly noxious, because it contains a large quantity of intermingled arsenious acid; but any orpiment is destructive, because it is spontaneously convertible, in the stomach, into sulphuretted hydrogen and arsenious acid. Arsenuret of tin, and native sulphuret of iron and arsenic (mispickel), are the only insoluble products of arsenic which have been found hurtless.

8. The least dose known to have killed a child, is four grains of white arsenic; the least dose actually fatal to an adult, was between twenty and thirty grains. *Opi-*

nion has been given in favour of the destructive power of much smaller doses.

9. The ordinary symptoms of poisoning begin *within* an hour, but arsenic has remained unobserved in the stomach for several hours. The latter effect has been attributed to the intervention of sleep, or the addition of a narcotic.

10. The death of a poisoned subject takes place at periods varying from three hours, to days, weeks, or even months. Very sudden death is *usually* produced by action on the brain or heart; dissolution after half a day and within three or four days, arises from inflammation of the alimentary canal; and when the fatal issue is remotely postponed, the patient dies of what have been called nervous disorders.

11. The first symptoms of arsenication are, usually, nausea, vomiting, and burning pain at the epigastrium, *sometimes* attended by heat in the fauces. But the variety of phenomena is very great, always, however, within limits which a well-informed observer may distinguish as arsenically-caused combinations. They are formed of irregularities of the circulatory, digestive, nervous, and muscular systems, with occasional disorder of the dermoid surface.

12. The *post-mortem* exhibits sometimes no marks of diseased structure, but generally there is found in the *primæ viæ* inflammation and its effects, from a slight blush, to the deepest red or the most melanotic blackness—from reticulated lymph on the surface, to effusion into and between the alimentary coats—from softening or hardening, or thickening or attenuation, of the velvet-membrane, to the perforation not only of that, but of all the walls of the canal. The surface is seldom altered, though at times blue spots are seen and desquamation of the cuticle observed. The circulating organs seldom indicate the cause of death. At page 283 of our article, may be found Christison's description of what he supposes characteristic marks of arsenical action, which it may be proper to say are described as effects of mere disease, by Andral, in his observations on *hyperemia* of the gastro-intestinal lining.

13. Arsenic introduced immediately after death, so as to lie in contact with mucous membranes, reddens only the parts touched, making abrupt well-defined marks. After twenty-four hours, its application causes solely similarly defined dark spots.

14. The antiseptic effects of arsenic are generally admitted to preserve parts in actual contact with it, but the question of a remote and general protecting sway is yet *sub judice*, although most of the German and a few of the great authorities elsewhere are disposed to admit its existence.

15. Arsenic is most speedily fatal when injected into the veins or when applied as a vapour to the bronchial tissue, or in solution to the alimentary canal. But it may destroy life by attacking any tissue,—from the sound cuticle to the lining membrane of the vagina, or the Schneiderian expansion of the nose.

J. K. Mitchell.

§ 3. *Therapeutic Application.* The energetic action of arsenic on the animal economy, and its frequent deleterious influences, have not deterred medical practitioners from resorting to its employment as a therapeutic agent. The necessity felt in all periods by the profession, of a resort to numerous substances endowed with the highest activity, manifests the intractable character of many of the maladies man is heir to.

Arsenic entered into the therapeutic resources of the Latin and Arabian practitioners. It was, however, rarely employed by them, especially in internal administration. They have left us no positive information available in its practical employment. For the advantages to be derived from this agent in the treatment of disease, we are indebted entirely to modern authorities and quite recent experience.

The introduction of arsenic into the Materia Medica has not been accomplished without opposition. Many of the continental writers, particularly amongst the French, condemn its employment entirely—and assert, that patients who have been treated by it die in a few months subsequently, of phthisis or chronic inflammation of some of the viscera. Apprehensions of this character are not without foundation, but they are greatly exaggerated. Clinical observations, by the best authorities in this country and Britain, establish the innocuousness of arsenic when administered appropriately, and the efficacy of its remedial properties when prescribed with skill and judgment. It cannot be denied, however, that arsenic, in its exhibition, is attended with hazard. It is to be resorted to only when other means prove unavailing, and the organs are in a condition to tolerate its energetic action.

Physiological Phenomena. The empirical employment of so powerful an

agent without reference to its influences on the organs, must be always a dangerous procedure. It must be adopted with extreme caution. Rational therapeutics or the determination of all the phenomena induced in the organs, and their influence in the curative operation, is the only safeguard against the dangers of heroic remedies and a perturbating treatment. But this has not been accomplished as yet for arsenic. The phenomena it excites have not been observed with sufficient accuracy —and in a spirit of rigid analysis.

In excessive doses, the symptoms are confused and varied. Phenomena resulting from its direct action on an organ are confounded, by the rapidity with which they are developed, with those of a secondary character proceeding from the sympathies of the organs or their dependence on the functions of each other. The properties of arsenic are so exceedingly noxious to every organized structure, vegetable and animal—are so destructive in their influence to the movements productive of vital phenomena, that, in large doses, vitality is extinguished immediately without any of those intermediate actions in the organs that constitute the therapeutic operations of medicines. Poisoning from arsenic furnishes but few indications for the establishment of its therapeutic mode of action on the organs. We can draw from it no positive inductions as to its *methodus medendi*, or rules for its practical employment.

When administered as a therapeutic agent, the effects of the remedy are often modified by the existing state of the organs; and symptoms belonging to the disease, but aggravated by its inappropriate employment, are frequently mistaken for phenomena caused by the agent itself.

To determine more accurately than had previously been done, the effects resulting from arsenic, HARLES instituted a series of curious and interesting experiments upon healthy adults. To these persons he administered the article in doses of from one-twelfth to one third of a grain; and he observed in them the following phenomena:

An increased heat of the whole body, the increase being more or less sensible according to the dose of arsenic.

A slight sensation of heat in the throat, extending down the œsophagus as far as the stomach. This ordinarily disappears on the second or third day.

A remarkable and almost constant increase of appetite. The occurrence of this phenomenon had been pointed out before, especially by HECKER, and has been confirmed by the observations of BIETT and CAZENAVE. If the dose of the medicine exceeds, however, one-eighth of a grain, there is, on the contrary, according to the experiments of HARLES, loss of appetite, with nausea, vomiting, &c.

Thirst and more frequent alvine evacuations, often alternating with constipation; or the latter may occur alone.

Increased secretion of urine and of the cutaneous transpiration.

More or less abundant salivation, in some rare cases, and when the use of arsenic has been long continued.

The pulse under the influence of the first doses of the medicine becomes sometimes soft and feeble, at others small and frequent. If the dose is increased, the pulse augments in force and frequency, afterwards again decreases so as to produce, according to HARLES, a species of remittent fever, but without regular type. M. BIETT has also observed in many cases these changes in the pulse. (*Dict. de Méd.* IV. 21.)

After the use of the arsenic has been persevered in for some days, the complexion assumes a sallow hue, the eyelids are tumid, the feet and hands swell, and a dropsical tendency is manifested, with an anemic aspect. Individuals who labour under predisposition to phthisis, are affected with cough, and the threatening symptoms of that disease appear; and those in whom chronic inflammations of any of the internal organs exist, present an aggravation of their complaints. The irritative affections of the stomach more particularly oppose the administration of arsenic. It immediately increases the symptoms and deranges more completely its functions. I have found a single drop of the solution of arseniate of potassa, in an irritable stomach, to produce nausea, vomiting, and thirst. Arsenic indeed seems to exert an especial action in augmenting the irritability of the stomach and intestines.

Taking, as our guides for determining the actions of arsenic, the most approved observations, it may be inferred that it causes two distinct phenomena in the economy. The first is a specific direct action destructive of vitality in the fluids and solids. It operates in this manner applied to ulcerated surfaces, and introduced in large doses into the economy. In the latter case, the death of the organ takes place without a vital reaction, and in consequence no pathological alteration of the structure is to be detected.

The second order of phenomena results from the vital reaction of the organic structure—the protective means of the economy—resisting the aggression of the destructive agent, protecting the organ acted on, and producing the operations for the elimination of the offending matter. In this respect, arsenic is always an irritant, exciting, according to the dose administered, an irritation varying from a light degree to the highest state of disorganizing inflammation.

Therapeutic Principles. The physiological phenomena produced by arsenic, lead to the establishment of the following general therapeutic principles for the regulation of its practical employment: 1. It is incompatible with all affections of the internal organs, especially of the stomach, of an inflammatory character, whether acute or chronic. 2. It should not be resorted to in the diseases of patients having a predisposition to phthisis. 3. It is to be used with great discretion, or entirely rejected, with individuals of feeble constitution, with those whose powers of life have been debilitated by disease, intemperance, or other causes that have impaired the nutritive and assimilating functions of the economy. 4. The dropsical diathesis, and a tendency to anemia, are counterindications to its employment. 5. In the lymphatic and nervous temperaments arsenic is not tolerated as freely as in the sanguine, and is to be employed with reserve.

Practical Employment. Experience has demonstrated that arsenic may be employed as a remedial agent in various affections. It is administered internally, and is frequently used externally as an escarotic.

In internal administration, the diseases in which it has been prescribed with most advantage are, 1. *Paroxysmal Affections.* The febrile paroxysmal affections are those in which arsenic has established its highest claims to confidence. Intermittent fever had been successfully treated with arsenical preparations by the common people of England and of Germany, before it was ventured on by regular practitioners. SLEVOGHT and FRICK, German physicians of repute, obtained favourable results from it in the treatment of intermittents. (1700–1710.) Upwards of three hundred cases are spoken of by them. The PLENCIZ of Vienna, father and son, after an extended experience, concurred in similar testimony to its safety and efficacy as a therapeutic agent in fevers.

But it is to Dr. THOMAS FOWLER that we are indebted for the more general knowledge of the utility to be derived from arsenic in intermittents. The testimony of FOWLER was sustained by ARNOLD, WITHERING, WILLAN, PEARSON, and others, in England. The experience of the practitioners of the United States equally proclaimed its salutary powers in intermittents. The fact is now generally admitted—it cannot be contested by the most prejudiced of its opponents.

Though arsenic possesses undoubted efficacy in the cure of intermittent fevers, it must not be considered as infallible, and regarded as a substitute for cinchona and its preparations. It frequently fails in accomplishing a complete cure. The same difficulty that is met with in this class of affections when managed by cinchona,—the liability to relapse—exists not less when arsenic is employed. It is less generally applicable also to the mass of patients, and more of danger as regards its inappropriateness to the constitution and general health of the patient is to be apprehended. There are many cases of intermittents of recent occurrence, and in individuals enjoying robust health, that may, *ab origine*, be treated by arsenic. But it is preferable, as a general rule, to rely on cinchonic preparations whose powers and mode of action are within the physiological limits of the organization. This circumstance forms the peculiar characteristic of the tonics, and renders them remedies of so much importance in the treatment of numerous diseases.

Arsenic, from its efficacy in intermittents, has been called a tonic. No appellation could be more inappropriate. No resemblance exists between the physiological phenomena induced in the economy by tonics and by arsenic. The actions of the first are in the line and within the limits of the healthy organic actions; they push these on to the highest point they can reach in the scale of health. They never denaturalize the organic actions. Arsenic, on the contrary, never acts in the line, or, if continued, remains within the limits of healthy action. Its effects on the economy are morbific—it entails necessarily disease: and it is most probable, that its influence in the prevention of the intermittent paroxysm, proceeds from the wide-extended pathological conditions in which it places both the solids and fluids of the economy, with the diminution of their vital forces. In consequence of this general pathological state attended with diminished power, the very active but irregular vital movements of concentration

and expansion, producing a flux and reflux of the fluids,—a movement of congestion overcome by a recuperative movement of reaction, in which consists the intermittent febrile paroxysm,—cannot be developed. The vital energies of no one organ, under the depressing action of arsenic, can acquire so much of an ascendency over the vital energies of the whole economy as to produce this irregular commotion—it might almost be termed insurrection—in the organs of the economy.

The practical employment of arsenic in intermittents must be regulated by the therapeutic principles laid down. It should not be administered in cases of persons predisposed to phthisis, nor in the cases of the grossly intemperate whose constitutions are broken down, and who generally labour under chronic inflammations of the digestive apparatus, or in whom the organs of that apparatus have suffered from pathological vitiation of structure.

Another practical consideration must not be disregarded. Chronic inflammations and other diseases of the viscera, often produce an intermittent febrile paroxysm, precisely resembling that of a regular intermittent. It occurs more frequently in individuals who have previously suffered an attack of intermittent fever. In them, the disposition to assume that type is so strong, that every source of disturbance to their economy is expressed by the intermittent paroxysm. The hectic of phthisis bears often so strong a resemblance to common intermittents, that I have known repeatedly the most experienced practitioners who neglected, or were ignorant of, the methods of determining by physical signs the state of the organs, to be deceived, and treat for several months a case of phthisis pulmonalis as an intermittent.

The far larger proportion of the cases usually regarded as chronic intermittents, and that prove rebellious to the ordinary modes of treatment for that disease, are of the character that has been mentioned. The administration of arsenic in those affections would be injudicious, and often prejudicial to the patient. The only treatment that will control cases of the kind must be based on appropriate regimen, local depletion if the nutrition be not too much impaired, and revulsives.

Remittent fever, it has been reported by FOWLER, and many subsequent English writers, may be controlled by arsenic. But febrile diseases with a remittent type are not all the same affections, and hence the appellation itself possesses nothing distinctive as a guide for the particular forms or states to which it would be applicable. In a climate like that of England, moist and cold, or like that of Germany, in which also arsenic has been recommended, fever manifesting a remittent type may be very different from fever in this country, especially in its southern latitude. In the United States, arsenic is seldom called in aid of the practitioner, for the management of this class of affections, and but little is known of its effects in them from experience. While we have means that command the confidence of the profession and are found adequate to the safe treatment of our remittents, so dubious a remedy as arsenic will not probably be enlisted.

Cephalalgia or *head-ache*, when it assumes a paroxysmal character is an affection in which arsenic is generally successful. Periodical head-ache is one of the diseases in which FOWLER has especially recommended arsenic, and of which he reports numerous favourable results. The experience of FOWLER has been justified by subsequent observations. This remedy continues to be resorted to when the affection resists other means that should be employed in the first instance. I have met with few cases in my own practice that have not yielded to the employment of the cinchonic preparations and mineral tonics. In some instances, head-ache can be distinctly traced to a connexion with a former attack of intermittent, or to exposure in miasmatic districts where intermittents are prevalent. It is then to be regarded as a concealed intermittent (*febris larvata*). Arsenic is an effectual remedy, as well as cinchona. There are also paroxysmal head-aches independent of any miasmatic contamination, arising from gastric disorder. They oppress the patient from severity of suffering. In many cases, arsenic has proved effectual for relief, though repeated failures occur. In these distressing affections, often resisting every variety of treatment, this efficient agent should not be overlooked.

Head-ache is often persistent, but attended with periodical exacerbations. Cases have occurred in the course of my practice, that appeared to have commenced in the earliest period of life. In one, the patient had no remembrance of a time when she had been free from pain in the head, and then was in her eighteenth year. She was disabled by its intensity from the performance of her duties in life, and debarred the enjoyments of society. All treatment had proved unavail-

ing. Arsenic procured a marked mitigation, but, after continuing its use at intervals for nearly a year, it was finally abandoned, the disease remaining. In several similar cases, the remedy proved equally unavailing. This form of the disease, from the only two autopsies I have had an opportunity of knowing, would appear to be dependent on a structural change in the arachnoid membrane with adhesions between its free surfaces preventing the gentle motion of the brain in movements of the body.

Paroxysmal neuralgia is found to yield to the action of arsenic. The neuralgic affections—that is, disorders of sensibility, are at this moment awakening the attention of practitioners. A good history of them is a work yet to be completed. They often are connected with intermittents, follow as one of their sequelæ, or appear to proceed from the same malarial poison developing paroxysmal febrile affections. This form of neuralgia has been noticed by MACCOLLOCH, who has been led to generalize the fact so extensively, as to regard all neuralgic diseases as forms of intermittent fever. There are neuralgic affections of a totally different character and origin. The generalization of Dr. MACCOLLOCH is too sweeping. When neuralgia assumes the complete intermittent type, attacking at regular intervals and a fixed hour, whether it has connexion with intermittent fever or arises from other causes, it is certainly controlled by the preparations of cinchona. Arsenic is equally effectual, but less prompt in its operation. I have never found it necessary to call in the aid of this preparation. The sulphate of quinia combined with sulphate of morphia, has in no instance that has fallen under my observation, failed in arresting the disease within forty-eight hours. The branches of the fifth pair of nerves, especially the supra and infra orbitar branches, have in my observations the most frequently manifested the symptoms of the affection.

2. *Cutaneous Diseases.* Arsenic has acquired a well-founded celebrity in the treatment of this class of affections. The cutaneous diseases to which it is adapted are those of the chronic character, unattended with febrile symptoms. In all of the exanthemata and febrile eruptive disorders, having a specific nature and passing through regular stadia, it is useless: it is not calculated in its mode of action to mitigate their symptoms, and cannot arrest their course.

Of the numerous cutaneous affections of a chronic character, it is only in a small portion of them that arsenic is admissible as a remedy. In many of these diseases, chronic inflammations of the internal tegument exist, as well as of the external tegument, and arsenic is very little compatible with that state. It may be established as a general rule for the employment of arsenic in the chronic cutaneous diseases, that it can never be relied on for producing favourable results, until the period of excitement, often very protracted, has terminated, and the internal surfaces are in a healthy condition.

Of the *vesicular inflammations*, eczema, when chronic, is the only one in which arsenic is employed. This affection, when it terminates in the production of a moist squamous crust, is exceedingly difficult to cure. Arsenical preparations are then amongst the most certain means. They are to be used, however, with caution, and not until the gastric and intestinal surfaces are free from irritation. The employment of these remedies must also be frequently suspended, and if signs of internal irritation be present, an emollient treatment should be interposed. It is necessary, in many cases, to prolong the use of arsenic in this form of the disease, under the precautions indicated, for a period of several weeks, and even for several months.

Of the *pustular* cutaneous affections, chronic ecthyma, chronic impetigo, and porrigo, are the only forms that admit of the arsenical treatment. These affections, when they resist the operation of other remedies, may be successfully treated by arsenical preparations. Complicated as they are so frequently with chronic inflammation of the digestive apparatus, the cautions heretofore laid down must be rigidly observed.

In the *papular eruptions*, arsenic is always injurious. This variety of cutaneous disease is intimately connected with varied irritations of the alimentary surface. It often supplants them, the external relieving the internal disease. A translation is easily effected, to the great disadvantage of the patient. I was tempted some years past, in an obstinate case of lichen agrius, of a chronic character, that had resisted treatment for upwards of two years, to venture on the administration of FOWLER's Solution. The affection was translated to the bowels, and my patient was for some days in danger with the symptoms of acute enteritic inflammation.

The *tubercular cutaneous diseases*, lupus, cancer, elephantiasis of the Greeks,

difficult under the most favourable circumstances to relieve, and often incurable, amongst the multiplicity of means resorted to, have been treated by arsenical preparations. The success of these remedies has been so very equivocal as to leave in doubt the propriety of their internal employment. In this country, lupus is a rare affection, and elephantiasis græcorum unknown as an original disease. I have witnessed but one case of this last. A military officer in the service of the republic of Colombia, in some parts of which the disease is endemic, came some years past to this city for advice in his case. Numerous small tumours, dense, firm, insensible, embedded in the skin and cellular tissue of the face and extremities, very slowly increasing in size, presented but few indications for the employment of any therapeutic remedies whose known mode of action could promise the eradication of an affection of this character. All the means called into operation failed; he left this country for France, in search of relief, and when last heard of was there in a deplorable state, endeavouring to procure a passage to his native country, but which he had found difficult from the repugnance excited by the aggravated state of the disease.

When arsenic is exhibited in these affections, as its employment must be long continued, it is to be given in small doses and but once or twice daily. The Asiatic pill containing the one-sixteenth of a grain of the protoxide, twice daily, is usually preferred.

The *squamous affections* of the skin, when they prove, as they frequently do, rebellious to the ordinary modes of treatment, may be attacked by the arsenical medicines. Willan, Bateman, Plumbe, Foderé, Duffin, Rush, and others, attest their efficacy in relieving these affections. Arsenic has, however, been often injudiciously prescribed in the squamous diseases, and injurious effects have resulted from them. In the early and inflammatory stages, arsenic is inapplicable: it generally fails. It is more frequently successful in cases that have become chronic and have continued a long period. Neither should it be brought into operation until after depletory means, emollient baths, and a suitable regimen, have been in operation. When these fail to accomplish a cure, they prepare the way for the successful co-operation of arsenic. It must not be overlooked that in these affections the digestive apparatus is often deeply involved, and irritations of considerable intensity exist. Arsenic is then injurious, from the aggravation of those affections, and is utterly unavailing in relieving the cutaneous disorder. I have treated a number of cases of lepra vulgaris and psoriasis, modifications of the same form of disease. In one that had continued for seventeen years, from childhood, the most complete relief was procured by the combined operation of bleeding, regimen, and emollient baths, followed up for several months, and finally assisted by Fowler's solution continued for eight weeks. In this case, the digestive apparatus manifested a perfect integrity of functions. In another case of eight years' duration, a similar treatment was equally successful after a treatment of two months. At this time there is under my charge a lady who has been affected four years with this eruption; but in her case such is the irritable condition of the stomach that a single drop of Fowler's solution cannot be taken. In lepra and psoriasis, it will most probably be found, that arsenic is not adapted to the treatment of the first periods. The emollients, temperants, depletives, baths, with the milder alteratives, are to be preferred. In many cases I have found that method the most available. But in ancient cases, when the local and constitutional irritations have subsided or are worn out, then arsenic will often prove an effectual cure.

In the eruptive and ulcerative affections of the internal teguments, the experience of the effects of arsenic is too limited to build on it any therapeutic directions. This class of diseases is yet too little known to justify positive methods of treatment. They are probably as numerous and as varied as those that are observed on their congenerous structure, the external tegument. The different sensibility, irritability, and important functions of the internal surfaces, modify very materially the symptoms and results of affections developed in them analogous to those of the skin. The same circumstances modify also the effects of remedies, and render those inadmissible in the one that may be perfectly adapted to the other. In the larger number of these affections, arsenic possesses powers too active, and influences too immediately the suffering surface, to be safely employed. The extent of what is known in this respect is, that in chronic ulcerations of the fauces and pharynx, unattended with febrile symptoms and gastric irritations, Fowler's Solution applied as a lotion, and internally administered, has often proved the most successful re-

medy after other means had been unavailingly employed.

3. *Syphiloid Affections.* Various eruptions, tubercles, and ulcers, appearing on the skin, osteocope pains, nodes on the bones, have often a character resembling affections formerly attributed to syphilitic virus. Their origin appears doubtful. This is not the place to discuss the question. In these affections, arsenical preparations are often successful even after a mercurial course has failed. Professor Physick has found the arsenical remedies, alternated with short and light courses of mercury, a very effectual treatment in this form of disease.

4. *External Application.* At one time, the arsenical preparations were very extensively resorted to as external applications, but the serious consequences which frequently followed their employment in this mode (see pp. 285–6.) have much restricted their use. With proper precautions they may, nevertheless, be resorted to in certain cases, with great advantage.

The employment of the arsenical preparations in cancerous and some other intractable affections, is sustained by a strong mass of facts derived from experience. The empirics who profess to cure cancers, and whose treatment is occasionally successful, in very bad ulcers, most commonly use arsenic disguised in some shape. As a general rule, the knife is to be preferred where extirpation can be accomplished. But there are cases in which this is not possible; and in others, where considerable mutilation would be required, a local treatment should in the first instance be attempted. Cancerous ulcers of the lips, of the nose and face, are often brought to heal by the use of arsenic. The powder of Dupuytren has been repeatedly successful in these cases. In two cases, one of the lip, and another of the nose, I obtained a perfect success. It does not appear to act as a caustic, but rather as a very powerful alterative of the organic actions of the part. Before applying it, the surface of the sore must be rendered clean by poultices. Many years past, I witnessed a successful treatment of a case of fungus hematodes (not Heys, which is the medullary fungus,) on the wrist, by Dr. Physick. The arm was confined in splints, and arsenic freely applied. The recovery was complete. Another, of medullary fungus on the arm, was successfully treated at Germantown, on the same plan. The patient has remained well for four years. It has been remarked that in cancerous affections, the local application of arsenic is not liable to produce constitutional symptoms. It does not appear to be absorbed from a cancerous surface. Some years since, the arsenical treatment procured a prolongation of life in a case that fell under my charge. The breast had been removed with the glands in the axilla, for a cancerous disease. Several tumours subsequently formed. They were hard at first, semitransparent, and straw-coloured. As they advanced, they became very vascular and of a bright scarlet. After some weeks, they would bleed. Various treatment was resorted to, and finally settled down to the application of Rousselot's arsenical paste. The tumours would slough off and be reproduced without extension of the base, at the end of three or four weeks. This plan was continued for three years. When I last heard, her general health remained unaffected.

As a means for arresting the progress of certain carcinomatous ulcers, and to change the mode of action of some chronic ulcers, arsenical preparations are sometimes employed with success. MM. Biett and Cazenave have obtained advantages from their application, in the cure of lupus (*Dict. de Méd.* IV. 31.), and Dr. Randolph has been equally successful with them in a case of peculiar ulcer of the scrotum. (*N. A. Med. and Surg. J.* V. 257.)

S. Jackson.

§ 4. *Pharmacy and Posology.* The preparations of arsenic, or those into which this substance enters as the chief ingredient, which have been employed in medicine, are exceedingly numerous; and although the greater number of them are now rarely, if ever, used, still it may be reasonably expected, in a work like the present, that those, at least, which have enjoyed most celebrity, should not be passed over without some notice.

Sulphurets of Arsenic. These are rarely used in medicine. Hecker, however, boasts of the efficacy of the following powder in intermittent fever: Take of the sesquisulphuret of arsenic, *half a grain*; white sugar, *half a scruple*; oil of aniseed, *one drop*. This is to be divided into twelve doses, of which one is given every hour during the apyrexia.

Orpiment also enters into the composition of the Green Balsam of Metz, of Lanfranc's Collyrium, and of many depilatories.

Arsenious Acid. This is employed in a variety of forms, both as an internal remedy and as an external application. The dose when administered internally is from one-twelfth to one-eighth of a grain.

The *Solution of* LEFEBURE, for the cure of cancer, consisted of arsenious acid, *two grains;* rhubarb, *half an ounce;* syrup of chicory, *q. s.;* distilled water, *a pint.* Of this mixture, a table-spoonful was given every night and morning, with a fluid drachm of the syrup of poppies. Each dose contained about a twelfth of a grain of the acid. The dose was gradually increased to six table-spoonsful. (*U. S. Dis.*)

Asiatic Pills. Take of arsenious acid, *sixteen grains;* powdered black pepper, *two and a half drachms;* mucilage of gum Arabic, *q. s.* The arsenious acid and pepper are to be long triturated together in a mortar, and the mucilage then added. The mass is to be divided into two hundred pills, each of which contains about one-thirteenth of a grain of the arsenious acid. The dose is one pill daily, and must not exceed two during the same period.

BARTON'S *Pills.* Take of arsenious acid, *two grains;* powdered opium, *eight grains;* soap, *twenty-two grains.* Make thirty-two pills, each of which will contain one-sixteenth of a grain of the acid. The dose for an adult is two or three of these pills daily.

PLENCIZ'S *Powder.* Take of white arsenic, myrrh, long pepper, and Armenian bole, *each two grains;* flowers of sulphur, *half an ounce;* antimonic acid, *one drachm.* Mix and pulverize very finely. The dose is six or eight grains in chamomile tea, which is given an hour or two before the paroxysm of intermittent fever.

FONTANEILLE'S *Powder for the cure of intermittent fever.* Take of white arsenic, *two grains;* calomel, *sixteen grains;* opium, *two grains;* gum Arabic, and sugar, of each *one drachm.* Mix together and divide into sixteen doses.

Arsenious acid is a powerful caustic, and it constitutes the basis of the powders and pastes employed as escharotics. These pastes are made by mixing with saliva or water, or gum-water, the arsenious acid or some one of the arsenical powders, as that of ROUSSELOT. This mixture should be made on a tile, with a spatula, and the soft paste thus made is to be uniformly spread with the instrument just mentioned over the surface to be cauterized. The layer of paste should never exceed a line or a line and a half in thickness. Care should also be taken to confine the caustic to the parts intended to be destroyed. The application of this paste occasions a burning pain, and often local symptoms of an apparently alarming character; such as erysipelas, with much redness and tumefaction, especially when the remedy is used to the face. These soon disappear, or readily yield to emollient and cooling drinks, pediluvia, a few leeches, or at most a small bleeding. A black, very thick, and firmly adherent eschar forms, which does not separate for a long time, often twenty or thirty days, or longer. Sometimes when it drops off, the cauterized part is covered with a more or less solid cicatrix.

Before applying the arsenical paste, the parts to be cauterized must be properly prepared. Thus, if there exist on them any crusts or vegetations, the former must be removed by emollient poultices; the latter must be excised, and the wound covered with agaric or lint, and three or four days suffered to elapse, till these foreign bodies are cast off. Sometimes it is useful to excite the surfaces by a blister, which is to be removed immediately before the cauterization is to be made. This precaution, M. CAZENAVE says, is often indispensable in the treatment of lupus, especially that form of it which M. BIETT has denominated *lupus with hypertrophy.*

With prudence and care in using these pastes, the untoward accidents which have resulted from their employment, and of which so many examples are recorded, may be probably always avoided. SABATIER, DUBOIS, DUPUYTREN, and PHYSICK, who have so frequently made use of them, have never witnessed any alarming consequences from their use; and CAZENAVE says that he has often seen them applied and used them himself, with like good fortune. They are unquestionably, however, very active medicaments, and their use requires the closest attention and utmost prudence.

ROUSSELOT'S *Arsenical Paste* for the cure of cancer, is prepared, according to the French Codex, of *two parts* of arsenious acid, and of *sixteen parts each,* of cinnabar and dragon's blood. CULLERIER attributes to the dragon's blood the property of preventing the absorption of the arsenic.

The powder of frère *Côsme* (*Pulvis Cosmii sive Bernhardii*) seems to have differed from that of ROUSSELOT in the proportions only of the ingredients. The formulæ for these preparations, as given by different authors, differ much.

Pomade of HELLMUND, for the cure of cancers of the face. Take of cinnabar, *half a drachm;* of the cinders of old sole leather, and dragon's blood, each *four grains;* of white arsenic, *twelve grains* (according to some formulæ, *ten grains*). Make a powder, and incorporate *a grain*

and a half of this with *a drachm* of the following ointment:—Take of balsam of Peru, extract of cicuta, each *one drachm;* of acetate of lead, *one scruple;* of laudanum, *ten grains;* of simple cerate, *two ounces.* This pomade at one time acquired such celebrity, that the secret of its composition was purchased by the Prussian government: it is a clumsy imitation of the Paste of Frère Côsme, and of the old anticancerous remedy of Davidson. It is no longer in use.

Arsenical Pomade. Take of white wax, *two drachms;* of butter, *six drachms;* of white arsenic, *four grains.* Mix.

Arsenical Cerate. Take of arsenious acid in very fine powder, *a scruple;* of simple cerate, *an ounce.* Mix the acid with the cerate previously softened by heat.

Swediaur's *Arsenical Liniment.* Take of arsenious acid, from *one* to *two grains;* oil of olives, *one ounce.*

Swediaur's *Anticancerous Cataplasm.* Take of white arsenic, *half an ounce;* camphor, *one ounce;* vinegar, *one pint;* juice of carots, *two pints;* powdered cicuta, *q. s.* Mix.

Plunket's *Caustic.* Take of the Ranunculis acris and Ranunculis flammula, each *an ounce,* bruise and mix with *a drachm* of arsenious acid and *five scruples* of sulphur. Beat the whole into a paste, form into balls, and dry in the sun. When used, it is to be rubbed up with the yolk of egg, and spread upon a piece of bladder. (*U. S. Disp.*)

Dupuytren's *Powder* is a mixture of the protochloruret of mercury and arsenious acid, in the proportion of two hundred parts of the former, to one or two of the latter. It is said to be a mild and often very useful caustic, and to be especially applicable to children and irritable individuals. It is dusted on the part we wish to cauterize. Most frequently it causes no pain; nevertheless, it is prudent not to apply it to too large a surface at a time. A grayish very adherent crust is soon formed, which does not separate for a long time, unless this is promoted by emollient applications. Ordinarily, it is necessary to apply the powder several times before a good cicatrix is obtained.

Dr. Hugh Martin's *Cancer Powder,* described by Dr. Rush (*Trans. Amer. Philos. Soc.* II. 212.), consisted of arsenious acid and vegetable matter; in the proportion of one part of the former to forty of the latter. In the specimen experimented on by Dr. Rush, the vegetable matter was belladonna. This powder seldom produced an eschar, but only moderate inflammation. Dr. Rush, who witnessed its application, bears testimony to its having performed complete cures in several cancerous ulcers, mostly seated on the nose or cheeks, or upon the surface or extremities of the body; but where the disease was connected with a scrofulous diathesis, it always failed, and in some instances did evident mischief.

Arsenical Ethiops, recommended by Adair for the cure of yaws and some other obstinate diseases of the skin, is prepared by well triturating together *one part* of white arsenic with *three parts* of sulphur. (Duncan. *Med. Comm.* for 1785.)

Lefebure's *Cancer Wash* consisted of ten grains of arsenious acid dissolved in a pint of distilled water, to which were added an ounce of extractum conii, three fluidounces of liquor Plumbi subacetatis, and a fluidounce of laudanum. With this the cancer was washed every morning. (*U. S. Disp.*)

Ioduret of Arsenic. This has been employed in the form of ointment only, for which the following is the ordinary formula: Take of ioduret of arsenic, *one part;* lard, *eighteen parts.* Mix.

Arsenite of Potassa. This salt is never used pure. Dissolved in water, it forms Fowler's Solution. The formula for the preparation of this, as given in the U. S. Pharmacopœia, is as follows: Take of arsenious acid in very fine powder, purest carbonate of potassa, each, *sixty-four grains;* distilled water, a sufficient quantity; compound spirit of lavender, *four fluidrachms.* Boil the arsenious acid and carbonate of potassa with *a pint* of distilled water, till the acid is entirely dissolved. To the solution, when cold, add the spirit of lavender, and afterwards sufficient distilled water to make it fill up exactly the measure of a pint. As observed by Dr. Bache (*U. S. Disp.* p. 795.), to form a perfect arsenite of potassa, theory would call for 50 of acid and 70 of the carbonate, instead of equal parts; so that the quantity directed of the latter is deficient. Each fluidrachm of the solution contains half a grain of the arsenious acid. Fowler administered this preparation in the dose of from ten to twelve drops two or three times a day. In this dose it is apt to disorder the digestive organs. In intermittent fevers we have found five or six drops three times a day to be generally sufficiently large doses. In diseases of the skin, where it is to be long continued, we prefer commencing with smaller doses, as three or four drops two or three times a day, and gradually increasing

them to six or seven drops during the same period. Few persons can support larger doses for any great length of time without experiencing gastro-intestinal irritation or irritation of the lungs. Mr. IRELAND states that he has given it in the enormous dose of two drachms, with constant success, for remedying the effects of the bites of poisonous serpents. An imitation of this practice cannot be safely recommended. In all cases, the employment of this active medicament should be closely watched, and the dose diminished whenever signs of gastric or intestinal irritation appear; and in chronic cases, where it is necessary to continue the remedy for a considerable period, it is most prudent occasionally to intermit its use for some days.

ARSENIATE OF SODA. This is the base of the arsenical solution of PEARSON and of that of HEINCKE.

PEARSON'S *Solution* consists of one grain of the arseniate of soda dissolved in one ounce of distilled water. This liquor contains one-eighth of a grain of the salt to each drachm, and the dose is half a drachm daily. In irritable persons, and especially females, it is best to give this quantity in two doses, or one-fourth of a drachm morning and evening. PEARSON gave it in doses of from sixty to one hundred and twenty drops, in intermittent fevers and cutaneous diseases. It is less dangerous and less active than FOWLER'S Solution.

Solution of HEINCKE. Take of arseniate of soda, *six grains*; mint-water, *two ounces and a half*; vinous tincture of cinnamon, *one ounce and a half*; laudanum, *one drachm*. The dose is forty or fifty drops four times a day.

Arseniate of Iron. Take of the protarseniate of iron, *three grains*; extract of hops, *two drachms*; powdered marsh mallow, *half a drachm*; syrup, *q. s.* Make forty-eight pills. This is recommended by some English writers for the cure of cancerous affections and herpetic ulcerations. The dose is one pill daily.

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I. HAYS.

ARTEMISIA. (*Botany* and *Mat. Med.*) *Sex. Syst.* Syngenesia superflua. *Nat. Ord.* Compositeæ.

Gen. Ch. *Involucre* imbricate. *Scales* round, connivent. *Florets of the ray* none. *Pappus* none. *Receptacle* naked, or slightly villous. BECK.

All the plants of this genus are bitter, aromatic, and possessed of medical properties. The genus is very extensive, being composed of upwards of one hundred species, all of which are found in the most sterile spots. None of them are recognized by the U. S. Pharmacopœia, and but few by those of Europe. These are

1. *A. absinthium.* Wormwood. *Absinthe,* Fr.; *Wermuth,* Germ.

Sp. Ch. Stem branching, panicled; leaves hoary; radical ones triply pinnatifid; divisions lanceolate, toothed, obtuse; cauline ones two-pinnatifid, or pinnatifid; divisions lanceolate, acutish; floral ones undivided, lanceolate. This species is a native of Europe, where it is also cultivated for medical purposes. It appears to be naturalized in most of the mountainous parts of New England (EATON), and is very common in gardens. It has a strong, penetrating smell, and an extremely bitter and aromatic taste, which it imparts to water and alcohol. It owes its properties to a dark-green volatile oil. Its medical properties are those of a stimulant and tonic, and it is much employed as a stomachic in the form of tincture. Before the introduction of Peruvian bark, it was a favourite febrifuge in intermittent fevers. As an emmenagogue it is of little value, though enjoying a high reputation as such, in domestic practice. It is also, like many of the other bitter herbs, much employed as an anthelmintic. It is an energetic stimulant, and should never be administered where any irritation of the stomach exists.

It is given in a variety of forms: 1. Infusion made with one ounce of the herb to a quart of water; 2. in powder, dose one to two scruples; 3. vinous tincture, dose half an ounce and upwards. The principal preparation, however, is the alcoholic tincture or Eau d'absinthe, which is much used in Europe, to excite the appetite.

2. *A. vulgaris.* Mugwort. *Armoise,* Fr.

Sp. Ch. Leaves downy beneath; cauline ones pinnatifid; divisions lanceolate, sub-toothed, acute; floral ones undivided, linear lanceolate; flowers sub-sessile, oblong, erect; calyx hairy. This is extremely common in Europe, and is also found in Canada and the New England States, on the banks of streams. It has somewhat the odour and taste of wormwood, but is less energetic in its action on the system. It is most generally employed as an emmenagogue, though its powers are but feeble and only suited to those cases where a slight stimulus is required. Some German writers have asserted that it has proved eminently useful in epilepsy, and many cases are reported in the foreign Journals in support of this opinion. Dr. BURDACH, who experimented largely with it, advises the following mode of administration: A dose of half a drachm of the powdered root is to be given, when the patient begins to experience the precursory symptoms, and he is to retire to bed to encourage perspiration. The second dose is two scruples. This is generally sufficient to arrest the paroxysm; if not, the succeeding doses are to be increased to a drachm or a drachm and a half. (*Archives Gén. de Méd.* VII. 588.)

Many other species of Artemisia have been employed for medical purposes. The *A. abrotanum,* or southernwood of the gardens, was at one time in high repute as an alterative and anthelmintic. The *A. dracunculus,* or Tarragon, is in general use as a condiment, but has not been employed for medical purposes. Several of the Asiatic species afford an anthelmintic much esteemed in Europe under the name of *Semen contra* (q. v.). The Chinese Moxa (vide *Moxa*) is prepared from plants of this genus. Finally, under the name of *Genipi* the Alpine species are in general repute in Switzerland as vulneraries and sudorifics.

R. E. GRIFFITH.

ARTERY. (From αηρ, air, and τηρειν, to retain or protect, because this term was at first only applied by the ancients, to the trachea, αρτηρια τραχεια, *arteria aspera*, and was not used in its present acceptation, until Erasistratus, probably from seeing the arteries empty after death, supposed they conveyed air from the heart and lungs, to all parts of the body, and applied the appellation to them which they have since borne.) αρτηρια, Gr.; *Arteria*, Lat.; *Artère*, Fr.

The arteries are elastic tubes, which convey the blood from the right and left ventricles of the heart, to every part of the body.

Art. I. *General Anatomy of the Arteries.* Examined in their totality, the arteries consist of two great trunks, which present an arborescent arrangement, the root of each being the base of one of the ventricles, while the numberless ramifications formed by its successive divisions and subdivisions, are spread out in the substance of the various organs to which the blood is circulated. The first of these trunks is the *pulmonary artery*, which, proceeding from the base of the right ventricle, sends its ramifications exclusively to the lungs, where they communicate with the radicles of the pulmonary veins, which return the blood to the heart after it has undergone the changes impressed upon it by respiration. These parts form what is called the lesser or pulmonary circulation. The second is the *aorta*, which proceeds in a similar manner from the left ventricle, but distributes its ramifications to every part of the body, where they communicate with the radicles of the veins, which return the blood to the right side of the heart. It forms, therefore, the trunk of the greater, or systemic circulation.

§ 1. *Type and distribution of the arteries.* The type of the arterial system may be compared to a tree, the trunk of which is rooted in the base of the ventricle of the heart, while its numerous ramifications branch into the substance of the various organs. The trunk, as well as the branches and ramifications, are for the most part perfectly cylindrical. But as the arteries divide and subdivide in their progress, the cylinders are perpetually growing smaller, as the arteries advance from the heart towards the periphery of the organization. Thus each artery, traced from its origin to its termination, represents a succession of tubes, or cylinders, of unequal size, terminating in each other, and becoming progressively smaller the further they are removed from the heart. A vessel examined in this manner, will represent a hollow cone, with its base directed towards the heart; but if attention be paid to its different segments, or the space between its several divisions, it will be found that they are cylindrical, and that the conical arrangement merely depends upon each division or bifurcation representing a smaller sphere than the trunk or branch which precedes it.

But while each artery, viewed in this manner, resembles a cone, with its base corresponding to the centre of the circulation, if the aggregate capacity of all the ramifications be compared with that of the aorta from which they proceed, it will be found that the former transcends the latter so far, that when the entire capacity is taken collectively, it will represent an inverted cone, having its summit directed to the heart, and its base forming the peripheral portion of the vascular system.

The order in which the arteries divide and subdivide, as they advance from the centre towards the circumference of the body, is subject to several varieties in different situations, but is everywhere radiated. Sometimes an arterial trunk or branch divides into two branches of nearly equal magnitude, as in the common carotid, the division of the abdominal aorta into the primitive iliacs, and the latter into the external iliacs. More frequently, however, the branch continues to distribute ramifications in its course, until it is entirely expended. The number of branches given off by any artery is subject to considerable variation. Haller and Meckel have estimated twenty as the maximum, under ordinary circumstances; but some anatomists have rated the number as high as forty or more. There are but few arteries which send off twenty branches between their origin and termination, and with a few exceptions, from ten to thirteen or fourteen may be regarded as the maximum. The internal maxillary and the ophthalmic may be taken as examples, each of which usually furnishes about thirteen branches.

The angle of bifurcation presents considerable differences, and cannot be referred to any fixed law. It was long since observed by Hunter, that those arteries which take their origin nearest the heart, generally come off at right angles, in order that the impulse of the blood which is strongest there, may be partially enfeebled or decomposed. This disposition is observed in the origin of the branches from the arch of the aorta, the lower

intercostals, the phrenic, cœliac, and emulgent arteries. Some even separate at obtuse angles, as, for example, the two coronaries, the superior intercostals, and the recurrent branches of the extremities. More generally, the angle of bifurcation is more or less acute, the degree of the angle varying very much, however, in the different arteries. Haller represented that the measurement, under ordinary circumstances, presents an approximation to 45°; but to this there are numerous exceptions; since many of them, as the spermatics, the carotids, and the arteries of the extremities, generally separate at angles which are exceedingly acute.

The diameter of many arteries is slightly increased at the point at which they are about to divide. This is especially manifest at the bifurcation of the common carotid. It was doubtless this dilatation, that induced Hunter to represent the arteries as conical, the expanded extremity of the cone being furthest removed from the heart. The internal aspect of the vessel also presents some difference, according as the bifurcation forms an obtuse, a right, or an acute angle. In the first case, there is an acute margin or projection corresponding to the point of separation, having its edge directed from the heart, and projecting more or less into the lumen of the artery. When the division takes place at a right angle, a similar margin occupies the whole contour of the branch which is given off; but when the direction of the bifurcation is acute, the prominent angular border, or spur, has its edge directed towards the heart, and is so disposed as to exercise considerable influence in dividing the current of blood into two streamlets when it impinges against it.

The arteries range for the most part in right lines, and many of them run parallel with the axis of the trunk, or the extremities, through which they take their course. Nevertheless, many exceptions to this rule are observed in the large trunks, as well as in the branches and smaller ramifications. Thus the aorta, even in the immediate vicinity of its origin, forms an extensive curve, while it is sweeping across the upper part of the thorax; and the intercostals, and the various circumflex and recurrent branches of the upper and lower extremities, run, for the most part, more or less transversely as regards the parts of the body in which they are situated. Many of the arteries are, moreover, somewhat flexuous or tortuous in their course, and in some of them this feature is very strongly characterized. As a general rule, those which are distributed upon parts which undergo much latitude of motion, or which are liable to frequent and sudden changes of position, or of form and volume, are the most tortuous. This is exemplified in the arteries of the iris, those of the lips, the heart, stomach, large intestines, and especially in the uterus,—likewise in the spermatic arteries, those of the spleen, and the umbilical arteries. We frequently see this condition accidentally induced in the dead body, when, in attempting to inject the vessels, the piston of the syringe is urged with too much force; and as they are acted upon in a similar manner by the impulse of the blood during life, it has been supposed by some anatomists, that even those which are found perfectly straight after death, are, during life, rendered more or less tortuous under the influence of each impulse of the heart. Some of the arteries present flexuosities, the object of which seems to be to decompose or enfeeble the impetus of the blood, and thus to protect the organ to which the vessel is distributed, from any injury which might proceed from a too vigorous circulation. Examples of this kind are furnished by the internal carotid, where it traverses the petrous portion of the temporal bone, and by the vertebral, at the point at which it is about to enter the cranium.

In most parts of the body, the origin of the arteries is but slightly removed from the organs which they are destined to supply, and even in their course to their point of destination, they usually distribute ramifications to the adjacent parts. It is true, some apparent exceptions to this rule exist,—amongst which the spermatic and ovarian arteries, and the internal carotids, as well as the vertebrals, may be enumerated. This difference, however, is easily explained, by the changes which take place in the relations of the organs subsequent to the period of the fœtal existence. During the earliest stages of development, the testicles are contained within the abdomen, near the point at which the spermatic arteries take their origin, and the neck being very short, the head is, during the first months of existence, placed much nearer the heart than at a later period.

All organs do not receive an equal supply of blood-vessels; but there are few which are furnished with less than two, and to many the supply is much more abundant. Nor is the size of the vessels always in relation with the volume of the organ to which they are distributed. Those

which are concerned in the elaboration of copious secretions, as, for example, the kidneys, the liver, and, in short, the apparatus of glands generally, either have arteries of a large size sent to them, or the deficiency of volume is compensated by number. Thus, the size of the arteries which are distributed to any part, does not furnish an accurate representation of the quantity of blood which it receives; for where a number of small vessels exist, they may collectively convey more blood than one of greater volume. The muscles, for example, are never penetrated by large arterial trunks, yet as numerous small ramusculi penetrate almost all points of their circumference, they are exceedingly vascular, and receive a large quantity of blood. In some organs which are supplied with a double set of blood-vessels, the latter differ from each other in the quality of the blood which they circulate, and also in relation to the functions which they subserve. The lungs, for example, receive black or venous blood through the pulmonary artery, which is conveyed to them merely to undergo those changes which are induced by respiration, while they at the same time are furnished with red, or arterial blood, through the bronchial arteries,—these latter conveying to them the elements of their nutrition and growth, and constituting the instruments of their preservation. The liver, in like manner, presents the same type as regards the distribution of its blood-vessels, with this difference only, that in it the black blood is circulated by the portal vein instead of an artery.

But while the number and size of the arteries going to an organ, may vary, the order in which they enter its substance presents everywhere one constant and unvarying character;—the trunk of the artery does not plunge undivided directly into the part which it is destined to supply, but divides into a number of branches or ramifications more or less considerable, which, radiating from each other, enter its substance at different points. If, by way of illustration, we trace the distribution of any artery into a large gland, we shall find it dividing before it plunges into the organ. The primitive branches, then entering at different points, take their course first in the space between the lobes, but dividing and subdividing in their course almost *ad infinitum*, in proportion as they become more minute, they follow the line of division between the lobules, then the interstices of the granules or acini, until, having reached their ultimate state of division, and attained a degree of tenuity which renders them invisible to the naked eye, they finally terminate upon the elementary granules, or particles, of which the gland is composed.

There are some structures of the body which, in the natural state, do not receive red blood, but through which a mere colourless fluid is circulated. The tendons, ligaments, cartilages, and fibro-cartilages, are of this kind. Others seem to be entirely destitute of vessels. This is true of the epidermis, the hair, nails, enamel of the teeth, crystalline lens, and probably the serous membranes proper, entirely divested of the subserous cellular tissue.

The symmetry of the arterial system is much less perfect than that of several other parts of the body. It is most perfect in the extremities, and in those organs which are themselves symmetrical; but in parts in which this character does not exist, or is but feebly developed, the arteries are more or less symmetrical. In this respect, there does not seem to be much difference between them and the veins. In the abdomen and the lower part of the thorax, the preponderance of symmetry is in favour of the arteries; for both the spermatic arteries proceed from the aorta, while one only of the corresponding veins terminates in the vena cava,—the left opening into the emulgent vein; and while the intercostal and lumbar arteries proceed from the aorta, a portion of the corresponding veins, instead of communicating with the vena cava, form the vena azygos and demiazygos. In the upper part of the thorax, however, the heart is not only inclined to the left side, but the branches which arise from the arch of the aorta differ on the right and left sides, while the right and left brachio-cephalic veins are symmetrical.

§ 2. *Anastomosis and termination of the arteries.* The arteries, though divided and subdivided almost to infinity, in the substance of the tissues and organs, are extensively associated with each other by anastomosis. Communications are formed between the trunks, the branches, and the most minute ramifications. Such connexions, however, are not established in the same manner in all parts of the vascular system; nor are they equally numerous in the several portions of the arborescent arrangement which it presents. There are comparatively few, the nearer we approach the centre of the circulation; but towards its periphery, where the minute divisions of the arteries acquire a capillary tenuity, they become so multiplied, as to

represent a complete net-work of vessels, inosculating with each other in a most complex manner.

Sometimes two trunks or two branches join each other at an acute angle, to form a single trunk or branch, which either pursues the course of the vessels by which it is formed, or departs more or less considerably from it. This is exemplified in the connexion which is formed in the fœtus, between the pulmonary artery and the aorta, by the ductus arteriosus, and in the vertebral, and the anterior arteries of the spinal marrow. The first of these connexions is confined to the period of fœtal life, and is destroyed after birth, by the obliteration of the ductus arteriosus. Somewhat more frequently, two arteries, running more or less parallel, are united by transverse branches, as is observed in the anterior cerebral arteries of the right and the left side, the connexion between these and the vertebrals, and that which exists within the substance of the placenta, between the two umbilical arteries. A similar association or anastomosis is, moreover, observed in some instances between the smaller ramuli; as, for example, where two parallel ramifications distribute their minute capillaries into the substance of an organ, and where the series of each intersect it at right angles. By far the most ordinary disposition of the anastomosis is that which takes place between the minute ramuscular extremities of the vessels, reduced to their ultimate state of subdivision. Here the anastomosing ramusculi approach each other, and unite by their extremities, to form arches, without there being any means furnished for determining precisely the point at which the one terminates and the other commences. This arrangement is observed in every part of the periphery of the vascular system, and is particularly important in the vicinity of the movable articulations, and in those situations at which the termination of different arteries is brought in relation with each other, inasmuch as these free anastomoses furnish collateral channels, through which the blood may be conveyed to its point of destination, when by accident, or an operation for aneurism or any other purpose, the main trunk, or an important arterial branch, has been obliterated. It is, indeed, upon this free anastomosis, that the success of such operations depends (see *Aneurism*); and in several cases where spontaneous obliteration of even the great trunk of the aorta has taken place, these collateral channels have compensated for the injury sustained, by transmitting sufficient blood to preserve the vitality of the parts interested. Some of the arches formed by these inosculations are exceedingly minute, while others are larger, and distribute from their convex surface, numerous ramuli to supply the adjacent parts. This arrangement is particularly manifest in the arteries of the mesentery and intestines, where a succession of arches is thus formed, each series becoming, as they progress towards the periphery, more and more minute. The same disposition is observed in the delicate vessels of the iris, and in those of some other parts of the body.

The vessels, in their ultimate state of division and subdivision, present a delicate arborescent arrangement, to which the denomination of capillary vessels has been applied. These attenuated vessels were unknown to the ancients, because they were not acquainted with the art of injection, which has done so much for anatomical science in modern times; and as they could not be traced with the naked eye, they escaped observation. But at the present time, notwithstanding the multiplied and luminous investigations which have been directed to the subject, and notwithstanding the collateral aids furnished by minute injections, the microscope, and other improved means of conducting researches upon objects so minute and complicated, much diversity of opinion exists in relation to the character of these vessels, the manner in which they terminate, and the nature of their connexions with each other, and with the veins and lymphatics.

As regards the first question, the opinions which have been advanced may be referred to two heads: 1. those who represent the capillary vessels as forming a system interposed between the termination of the arteries and the radicles of the veins; and 2. those who merely view it as the transition from the arteries to tho veins, and composed of the terminations of the one, and the commencement of the other.

The first of these opinions has been advocated by Bichat and Autenreith. The latter has indeed affirmed, that the capillary vessels represent, in the order of their arrangement, the type of the vena portarum;—that each capillary branch, like the trunk of that vein, is ramified at both its extremities, and that by one series of these ramifications it anastomoses with the termination of the arteries, while the other series forms a similar connexion

with the veins; so that the entire arrangement forms a system apart, interposed between the termination of the arteries and the commencement of the veins, the ramifications of which convey all the materials of nutrition to the various tissues in which they are distributed. But notwithstanding considerable modifications are observed, both in the texture and vitalism of these vessels, and in the properties of the fluids which they circulate, results furnished by minute injections and other means of investigation, are unfavourable to the inference of Bichat and those who concur with him, and positively disprove the hypothesis advanced by Autenreith. Nor does there seem to be any valid foundation for the belief advocated by Haller, Hewson, Sœmmering, Bichat, Chaussier, and others, of the existence of a distinct set of attenuated capillary vessels, merely capable of circulating a colourless watery fluid, which they have denominated exhalants. It is highly probable, nevertheless, that some of the capillary vessels proper, attain such an extreme degree of tenuity, as to be incapable of circulating red blood, and which consequently merely convey a white or transparent fluid. Such an opinion seems at least to have some foundation, when we attend to the appearances presented by these vessels in some of the tissues, and under different modifications of their vital acts. Certain it is, that in many parts of the body, no capillary vessels conveying red blood can be discerned in a state of health; yet when these same structures become the seat of disease, they are permeated by an infinity of red vessels, which form a complex vascular, reticulated arrangement, presenting the same appearance as the vascular ramifications observed in other tissues. In explanation of this phenomenon, it has been affirmed, it is true, that such vessels always convey red blood, but as the stream is so minute, being merely composed of a single series of globules, the natural red colour is concealed in consequence of the quantity being too small to manifest the usual characteristic. But while this argument is somewhat corroborated by certain physical facts, it is far from being conclusive. Vieussens, Boerhaave, Haller, and many physiologists in modern times, have contended for the existence of vessels, continuous with the red capillaries, which merely transmit a transparent or colourless fluid; and Bleuland even asserts that he, in one instance, succeeded in demonstrating these vessels. Notwithstanding, therefore, it has been contended by Prochaska, Mascagni, &c., that there are no vessels of the kind in question, there are certain phenomena of circulation, nutrition, and secretion, which, the present state of our knowledge, it is difficult to explain in any other manner than by a reference to such instruments. Broussais, indeed, and some other modern pathologists, have not only admitted that they exist, but have likewise imputed to them an important agency in the various *sub-inflammations*, and many other pathological states. It is reasonable to presume, from the absence of red capillary vessels in the cartilages and many of the other white tissues, and from their extreme paucity in some of those which are more highly coloured, that nutrition, secretion, &c., could not be adequately performed by the small number of vessels which can be rendered apparent by injection or other means, and without the concurrent agency of others, which though so attenuated as to escape our means of investigation, probably exist, and form an important part of such portions of the organization.

A more important question is, the manner in which the arteries terminate; the nature of their relations at this point with the tissues to which they are distributed; and the character of their connexions with the veins and lymphatics.

Aristotle supposed that the arteries end by blind extremities in the tendons, and through these latter terminate in the bones. Aretæus, Galen, and others of the ancients, corrected the hypothesis of Aristotle; but, embracing the opinion that these vessels have open extremities, they supposed that the blood thrown from them forms a kind of parenchyma, of which the liver, kidneys, spleen, &c., are composed. A modification of the doctrine of the open extremities of the capillary arteries, is advocated by respectable authority at the present time; and although a majority of anatomists and physiologists believe that the arteries are continuous with the veins, the opposite sentiment has many able supporters, and should not be too hastily rejected. The results obtained by minute injections, and the phenomena presented by the capillary circulation in the transparent animals, prove incontestably, that the blood passes in continuous streams from the arteries into the veins; but it is not so satisfactorily proved that these streamlets are contained within proper vascular tunics. Haller, and many before his time, believed that the vessels

open by pores, through which the blood, or the materials formed from it, escape into the surrounding parts. This view has been advocated by many modern anatomists, and especially by PROCHASKA, MASCAGNI, WEDEMEYER, RATHKE, HOME, GRUITHUISEN, FODERÉ, and many others. HOME represents that he discovered these pores in the vessels of the suprarenal capsules, but they were too minute to transmit a globule of blood, and merely allowed particles of oil to exude. WEDEMEYER found the arteries of the air-cells of the salamander's lungs gradually losing their tunics in the parenchyma of the organ, and presenting a perforated or sieve-like arrangement, through which the blood globules were transmitted (*Uber den Kreislaufe des blutes*, in MECKEL's *Archives für Anat. und Physiol.* 1828. p. 348.); and a similar arrangement has been observed by ANDRAL in the vessels of the spleen.

Whether these pores exist or not, for the deposit of the materials of nutrition and secretion, it seems to be highly probable, that while there is a direct continuity even by their tunics between some of the arteries and veins, there is interposed between others a species of parenchyma, or organic substance, through which a portion of the blood circulates in numerous streamlets, without being contained within any proper vascular tunics, but in immediate contact with molecules of the tissue itself. This view of the subject has been advocated by WOLFF, HUNTER, DÔLLENGER, GRUITHUISEN, OESTERREICHER, WEDEMEYER, BAUMGARTNER, WILLBRAND, KALTENBRUNNER, &c., who have adduced many forcible arguments in its support. By them, it is represented, that where the capillary vessels attain an extreme tenuity, their tunics entirely disappear, the blood beyond that point being merely circulated through channels, composed, according to DÔLLENGER, of a kind of mucous organic substance, a part of it in this transit being converted into the proper substance of the tissues, and into secretions, while the other portion continues its course to the radicles of the veins and lymphatics, which it enters, and is returned to the centre of circulation. In this muco-organic substance, therefore, he represents that important metamorphoses take place in the blood, as well as in the organic solids. The former is in part transformed into organic elements and secretions, or becomes solidified and assimilated to the property of the tissue in which it is deposited, while the latter are at the same time liquefied, and reconverted into blood, which is again conveyed by the veins and lymphatics on the devious round of the circulation. (*Was ist absonderung und wie gescheicht sie?* p. 25, 26.; also, *Denkschriften der Königlichen Akad. der Wissenschaft. zu München.* 1809.) WILLBRAND, adopting a similar opinion, has extended the principle still farther. He denies that injections and microscopical observations, made on the circulation in transparent animals, should be admitted as conclusive evidence of the continuity of the arteries with the veins. He even asserts that there is, properly speaking, no circulation of the blood, but that the heart and arteries merely distribute that fluid to all parts of the body, and that when it arrives at the termination of the capillary arteries, it all undergoes a metamorphosis, by which it is in part solidified, or organized, and in part transformed into secretions, while the solids are, at the same time, liquefied, to form the venous blood, which is generated at this point from the organized solids, and is not a mere continuation of the arterial blood. (*Isis:* also, *Journal Complimentaire des Sciences Médicales.*) According to this hypothesis, a solid barrier is interposed between the termination of the arteries and the origin of the veins, which, however, is incessantly forming and decomposing; for every particle of blood, as soon as it has reached that point, is solidified, or forms secretions; but the state of solidity is merely temporary, inasmuch as it is as speedily broken down, to form the venous blood, and the fluids circulated by the lymphatic vessels.

An opinion somewhat similar has been advocated by SPITTA (*De sanguinis dignitate in path.*, &c. Rostochii, 1825.), RUNGE (*Zur lebens-und Stoffwissenschaft des Thieres.* Berlin, 1824.), SACHS (in *Heusinger's zeitschrift für die organische Physik.* Eisenach, 1827.), and SCHULZ (*Ueber Blutbildung und Blutbewegung*, in MECKEL's *Archives für Anat. und Physiol.* p. 487. 1828.). Arguments in support of it have been adduced from the disproportion between the quantity of the arterial and venous blood; the dissimilarity in the properties of the two fluids; the suddenness with which the transition takes place, the change being too palpable to be effected while the blood is flowing in a continuous stream; the phenomena furnished by microscopical observations; and from the consideration, that nutrition and secretion could not be accomplished if the streamlets of blood merely flowed

onwards, from the arteries into the veins, inclosed within the capillary vessels. There can be but little doubt that some of the individuals mentioned have extended their inferences beyond their legitimate boundaries, and have formed conclusions which cannot be justified by fact; yet we think it equally clear, that those who have adopted the opinion, that the blood nowhere circulates in immediate contact with the parenchyma of the tissues, are equally in error, since, conformably to their hypothesis, the acts of secretion, nutrition, and exhalation, could not be accomplished, inasmuch as the blood being everywhere contained within the tunics of the vessels, and the arteries being continuous with the veins, the materials which are the product of these acts, could not be separated from the blood. It is true, that Prochaska, Mascagni, and some others of the opponents, have admitted that the coats of the vessels are perforated by minute pores, and that through these, particles escape; but if this be granted, they defeat their own argument, and virtually adopt the sentiment of those who maintain that a portion of the blood merely circulates in streamlets which permeate the organic parenchyma in direct contact with its substance, and without being inclosed in any vascular tunics. Nor can the inceptive condition of the blood-vessels which is observed in the incubated egg, in the embryo of more perfect animals, or the development of new vessels in a part of recent formation, admit of any other explanation. Thus, for example, if we watch the process by which these results are achieved, we shall first perceive in the substance which is to become the seat of the vessels, a few isolated points, of a reddish colour. From these points, which are particles of blood developed in the mass, radii afterwards shoot out in various directions, which are permeated by as many streamlets of blood, advancing from the central point towards the circumference. Many of these radii finally meet, or intersect each other, thus forming numerous inosculations; and an infinity of minute channels, conveying red blood, are in this manner formed, which represent the rudimentary type of blood-vessels; and by subsequent changes, each of these channels becomes supplied by proper vascular walls, furnished in part by the solid mass which they traverse, but in part likewise by the plastic powers of the blood itself. In corroboration of the same view, it may moreover be remarked, that when the transparent part of a living animal is irritated, streamlets of blood globules are seen rushing from every point towards the centre of irritation, and these streams continue to increase when the irritation is protracted, until the whole tissue, which was previously, to all appearances, bloodless, seems to be permeated in every possible direction, with myriads of capillary channels, circulating red blood, all communicating with each other, but constantly changing their direction and the order of their connexions.

From what has been said, it is manifest that our opinions upon this obscure and intricate part of anatomy, must be, to a great extent, merely conjectural, and that where demonstration is so difficult, caution should be observed in forming positive conclusions. The authority is respectable upon both sides of the question at issue, but we are inclined, notwithstanding the arguments adduced by Leuwenhoeck, Haller, Spallanzani, Prochaska, Bichat, Rudolphi, Muller, and others, to prove that the blood does not pass from the arteries to the veins in any other manner than by a continuity of vessels, to adopt an opposite opinion. The minute and elaborate investigations of Wedemeyer, as well as many other facts and arguments which might be adduced, serve to demonstrate, that the arteries manifest different modes of termination, according to the relations of their capillary extremities, and the offices they have to perform. 1. The largest capillary ramifications are continuous with the radicles of the veins, the blood throughout the whole of its transit from the one set of vessels to the others, being contained within proper vessels. 2. Other streamlets of blood, of greater tenuity, permeate the parenchyma of the tissues, through numerous channels, the walls of which are formed by the tissue itself, without the intervention of any vascular tunics. 3. There are no facts demonstrative of any direct continuity of terminal extremities of the arteries with the radicles of the lymphatics, but, on the contrary, all that is known on the subject, seems to favour an opposite conclusion. It should nevertheless be remarked, that Mascagni and Lauth have traced lymphatics taking their origin from the tunics of the arteries. 4. The arteries probably do not communicate directly with the excretory vessels of the glands, as was supposed by Haller, but become divested of their tunics in the immediate vicinity of the radicles of those vessels, so that the blood which is appropriated to the purposes of

secretion, is placed in immediate contact with the substance of the organ, and circulates in the interstices of its molecules. This seems to be the case in the liver and kidneys. 5. The same disposition apparently exists in the termination of the arteries upon the exhalant surfaces. Beyond the point to which the tunics of the vessels extend, the blood probably traverses capillary channels which permeate the parenchyma of the tissue, until it finally reaches a more porous arrangement, through which the serous fluid percolates until it escapes upon the surface of the membrane. As regards the absence of all direct communication between the blood-vessels of the liver and the radicles of the excretory vessels, there can be but little doubt, as injections have failed to demonstrate it. Even Muller, who is one of the most recent and able opponents of the opinion which we have adopted, is obliged to concede this point. He remarks, that even with the assistance of the air-pump, minute injections could not be made to pass from the blood-vessels into the excretory duct of the gland (*Mikrometrische mcssungen der Acini und sccrctfuhrenden Kanâle der Drüsen im injicerten*, &c., in Meckel's *Archives für Anat. und Physiol.* p. 58. 1830.); and in another place he observes, that when air is blown into the vena portæ, the liver is easily inflated, and the air passes with facility into the vena cava, and even to the heart, but cannot be forced into the radicles of the hepatic duct. (*Ueber den krieslaufe des blutes in der Lcber der jungen Salamanderlarven. Op. Cit.* p. 191. 1829.)

§ 3. *Structure of the Arteries.* The arteries are composed of three concentric layers or tunics, each of which presents properties peculiar to itself. These are the *external*, or *cellular*, which unites the vessel with the surrounding parts; the *middle*, *fibrous*, or *elastic*, sometimes called *muscular coat;* and the *internal*, *serous*, or *proper tunic* of the vascular system.

a. The *cellular coat* of the arteries is flocculent on its outer surface, by which it is connected with the surrounding parts, and is composed of compact cellular tissue, which is more firm and filamentous than that which occupies the interstices of the organs. These filaments are closely interwoven with each other, and are of a whitish appearance. Those, however, which compose the outer part of the tunic, are more loosely united, and are more flocculent, than those which are deep-seated;—the latter being generally so condensed, that the proper structure is only seen well, when the part is submitted to forcible traction. Scarpa has maintained that this cellular tunic does not appertain specially to the arteries, but merely consists of a portion of the cellular tissue which is common to all the organs. There are, however, qualities by which they are palpably distinguished. It is much more compact and resistant; its filaments are more closely interwoven; its interstices never become the seat of adipose or serous deposits, and when its external surface is detached from the surrounding parts with which it adheres, it may be stripped off from the adjacent fibrous coat, in form of a continuous membranous cylinder. This separation is the more easily accomplished, because of the extreme tenuity of the adhesion between the two tunics

This coat, which is elastic and highly extensible, is at the same time endowed with great strength. It preserves the flexures of the arteries, which disappear as soon as it is divided or destroyed. It imparts to them their principal faculty of resistance, and is the only one which sustains a ligature when this is applied to an artery, both the others, in consequence of their extreme fragility, being easily divided; and in most cases of aneurism, it becomes more or less distended, and forms the proper sac.

b. The *elastic*, *fibrous*, or *middle coat*, sometimes improperly denominated *muscular coat.* This is by far the thickest coat of the arteries, especially of the large trunks and primitive branches, and it is to this structure that these vessels are mainly indebted for their elasticity. Meckel has also affirmed that the principal resistance of the arteries is owing to the fibrous tunic; but we think this expression needs some qualification, inasmuch as the elastic fibres of which it is composed, are very fragile, and frequently give way, leaving the column of blood to be sustained by the cellular coat, as in aneurisms. This tunic is of a lightish yellow colour, sometimes presenting a very slight shade of pink. It is more or less compact, highly elastic, and so exceedingly fragile, that it gives way, or is divided, under very slight force. Hence, as was long since demonstrated by Desault and Jones, it is always severed by the constriction of a ligature applied to an artery. When carefully examined, it is found to be composed of fibres, or rather of very thin laminæ, which form concentric circles, twining round the circumference of the vessels, but being

generally a little oblique or spiral in their arrangement, so that the circles are incomplete. The fibres are intimately interlaced with each other, and their connexion is rather effected by this interlacement than by the intervention of cellular tissue. Hence, as the filaments are very fragile and delicate, they can be easily separated.

The fibrous coat exists in all parts of the arteries,—in the ramifications, as well as in the trunks and branches. Boerhaave, and some others, supposed that the arteries of the brain are destitute of it. But this opinion is not correct. It is merely thinner there than elsewhere, in consequence of which, those vessels, when divided, collapse like veins, while in the other arteries, the elastic coat maintains their proper cylindrical configuration when they are empty or severed transversely. But while the elastic tissue exists in all the arteries, it does not seem to present precisely the same properties at all points. It was remarked by Hunter, that it is redder and more irritable in the small ramifications than in the large trunks; hence he conceived, that in the former, contractility was more energetic, and in the latter, elasticity.

Besides the circular fibres of the arteries, Willis and some of the older anatomists described a longitudinal series as appertaining to these vessels. No such arrangement has been demonstrated, and the only approximation to such a condition, that we have been able to discover, consists in a few slight longitudinal folds which we have occasionally discovered in the large trunks, and especially in the pulmonary artery.

The fibrous coat of the arteries, which was generally regarded as muscular, was first shown by Bichat to possess very different properties, and the subsequent researches of De Blainville, Dupuytren, Beclard, Mascagni, Hauff, Meckel, and others, have demonstrated that it should be regarded as a peculiar tissue, to which the appellation of elastic has been applied. The same species of tissue exists in various parts of the body, as, for example, in the trachea and bronchia, in some of the excretory ducts, and in the interstices between the arches of the vertebra, where it forms the yellow ligaments. It also forms the ligamentum nuchæ, the fibrous covering of the spleen, the ovaria, the penis, &c. It differs from muscle in structure, in chemical composition, and in vital endowment. Its fibres are less parallel, and are infinitely more fragile. They have not the colour of muscular fibres, and are not, like them, united by cellular tissue, or at least if that tissue does exist, it is in such small quantity, and so exceedingly delicate, as to exercise a very trivial agency. The fibres, moreover, can be much more easily separated. It also differs from the fibrous arrangement of the tendons, in characters which are equally palpable.

The fibrous coat of the arteries, when submitted to the drying process, parts with but little water, assumes a deep yellowish-brown, and sometimes even a black colour. By immersion in water, its elasticity is restored. It is tardy in taking on the putrefactive process, and often resists even until the surrounding parts are entirely destroyed. It also differs from muscle in the following particulars: It is completely insoluble in boiling water, so that water in which it has been boiled even for several hours, throws down no precipitate when powdered galls are added. Nor is it either softened or dissolved by cold or boiling acetic acid, but the nitric, sulphuric, and muriatic acids, dissolve it readily, even when diluted. This solution, however, manifests no precipitate on the addition of an alkali, or of the ferrocyanate of potassæ, which it should if it contained fibrine. (Berzelius. *Traité de Chimie.* VII. 84. Paris, 1833.) It will thus be seen, that in all these particulars, the elastic fibrous tissue differs from muscle. The predominant ingredient of the latter, it is well known, is fibrine; —in the former, this principle cannot be detected by the most careful analysis.

As regards its endowments, it presents properties equally striking, by which it contrasts with muscle. In the one, elasticity constitutes the most remarkable attribute;—in the other, it scarcely exists. In the arterial tissue, but slight evidences of irritability can be developed by galvanism or other means: the muscular tissue, on the contrary, possesses this property in a remarkable degree. Thus, although the arteries display more or less contractile force in the circulation of the blood, this contraction is very different from that which takes place in the muscular system.

c. The *internal tunic of the arteries.* (*Tissu kysteux angéial*, De Blainville; *Tela vasorum communis*, Weber et alias.) This tunic or membrane is remarkably thin, and presents a whitish homogeneous appearance when examined in connexion with the parts to which it adheres, but is transparent when perfectly isolated. It is

compact, fragile, smooth, polished and lubricated upon its free surface,—rough and uneven on its external face, by which it adheres to the fibrous coat of the arteries and to the muscular substance of the heart. This surface adheres so closely in the arteries, that it cannot, in the fresh state, be separated to any extent from the adjacent fibres. It has, indeed, been remarked by Albinus (*Annotat. Academicæ.* Lib. IV. cap. 8. p. 30.), that there seems to be a continuity of substance between it and the elastic fibres, and that they are not united by cellular tissue. The same remark has been repeated by most modern anatomists, and even by Bichat. There are reasons, however, for presuming that the inference is not correct. By immersion in boiling water, by the process of boiling, and even by protracted maceration, in water frequently renewed, it may sometimes be separated in portions of considerable extent, which could not be accomplished if it possessed a direct continuity of substance with the fibrous structure. The presence of this delicate cellular tissue is, moreover, rendered probable by the phenomena presented by inflammation of the vascular tunics, by the frequent development of calcareous transformations beneath the lining membrane, and by the occurrence of tuberculous, atheromatous, and other degenerations in the same situation. In the cavities of the heart, indeed, the intervention of cellular tissue between the lining membrane and the muscular substance of the organ, can be satisfactorily demonstrated, because here the delicate vascular tunic can be detached with great facility.

This membrane is common to the whole vascular system, the type of which it accurately represents. The heart is its great centre, and after lining the cavities of this organ, it follows the ramifications of the arteries, the veins, and lymphatics, accompanying all their divisions and subdivisions, to their ultimate terminations, and constituting their proper lining. It does not, however, present the same properties and distribution in all parts of the vascular system. In the heart, it is reflected over the muscular bands or columns. At the orifice of the aorta and pulmonary arteries, it is doubled upon itself, to form three uniform lunated duplicatures, with free or floating margins, denominated semilunar valves, which prevent the blood from being thrown back into the ventricles during their dilatation. (See *Heart.*) It also forms the mitral and tricuspid valves, and the valves of Eustachius and Thebesius. In the arteries, it is distributed uniformly, except at their bifurcations, at which points it seems to be somewhat thickened, and contributes to form a prominent margin, by which the diverging streams of blood are more readily separated from each other. In most of the veins, however, as well as in the lymphatics, it forms numerous duplicatures or valves, all having their free edges directed towards the heart. Of these, some are double, and are placed opposite to each other, while the majority are single, and only occupy one side of the vessel. It is thicker and possessed of more density in the arteries than in the veins, and the lining membrane of the latter presents these properties in a greater degree than that of the lymphatics, which, according to De Blainville, is much more spongy, and approximates nearer to the properties of a mucous, than to those of the proper vascular tissue.

The intimate organization of this tissue has not been very satisfactorily determined. Bichat regarded it as a kind of epidermis, destined to protect the internal surface of the vascular system. Mascagni affirms that its free surface exhibits a kind of tomentose arrangement, which represents the orifices of lymphatic absorbent vessels thus taking their origin from the inner surface of the arteries. He hence conceives, that it is composed entirely of these minute vessels, and has, from this circumstance, denominated it *lymphatic tunic.* (*Prodromo della Grande Anatomia.* I. 193. Milano, 1821.) When brought under the field of the microscope, it presents, according to Milne Edwards, a number of globules $\frac{1}{300}$ millemetre, or $\frac{1}{7500}$ of a French inch in diameter. Others, however, have asserted that it furnishes no indication of either globules, fibres, or cells. De Blainville, and Hodgkin and Lister, have nevertheless affirmed that the lining membrane of the arteries exhibits a kind of serpentine or spiral arrangement. Inasmuch, however, as this appearance could only be observed in the arteries, it is probable that it was owing to the elastic fibres not being completely detached from the outer surface of the membrane. It is destitute of both vessels and nerves: at least, neither have been satisfactorily traced into its substance. This opinion has been advocated by Rudolphi, Sœmmering, and others, and is apparently borne out, both by examination, and by analogy. The delicate cellular tissue which connects this membrane to the fibrous tunic, is traversed by numerous

minute vessels, which, in a state of inflammation, were found by Ribes, forming a very delicate plexus upon the outer face of the proper vascular tunic. Nor is the vascularity of the membrane proved by the deep-red suffusion which it presents in disease; for its tenuity is such, that this appearance can be easily explained by the redness which is seated beneath showing through it.

From all these considerations, we are inclined to adopt the conclusion, that the lining membrane of the vascular system should be classed amongst the simple uninjectible tissues. It indeed consists of a thin porous or permeable pellicle, everywhere lining the organs of circulation, and presenting most of those properties which distinguish the serous membranes proper. This analogy is, moreover, demonstrated by the distribution of the vascular tissue, by the changes which it undergoes in disease, and by its vital properties. De Blainville has, indeed, affirmed, that this tissue, like the serous membranes, represents a sac reflected and ramified, and everywhere continuous, the centre of which is the heart, but which branches from this point throughout every part of the system, thus forming the infinity of channels which are represented by the arteries, veins, and lymphatics. Hence, these ramifications, in advancing from the centre towards the circumference, diminish in size, until they merely form capillary tubes, ending in the parenchyma of the tissues, or continuing with the radicles of the veins. It should be observed, moreover, that in those situations where an impulsive agent is requisite, the fibrous tunic is superadded, to perform this office; but in the extreme capillary ramifications, the minute channels are merely surrounded by this delicate membrane, exterior to which there is nothing but the parenchyma of the tissue which they traverse. (De Blainville. *Cours de Physiologie générale et comparée.* II. 280.)

This view, so far as properties of structure are concerned, is unquestionably correct. Yet, if with Bichat, and the unanimous sentiment of the present day, we assume as the type of the serous membranes, a sac reflected, and without opening, it will be difficult to reduce the type of the vascular system to this standard. It is not a reflected membrane; its ramifications do not terminate in blind extremities, but a portion of them become gradually lost in the porous parenchyma of the tissues, while others communicate directly with the radicles of the veins. But be this as it may, there is certainly an identity of structure, and the only reason why their types cannot be made to correspond is, that our definition of the serous membranes is too exclusive. Whatever may be their form, we are satisfied that Chaussier, Rudolphi, Ribes, and others, have correctly represented the serous membranes as merely consisting of a kind of inorganic, condensed pellicle, limiting the surface of organs and cavities, and that the tissue under consideration is of the same character. All the apparent vital phenomena presented by either, are attributable, for the most part, to modifications taking place in the delicate cellular tissue, which everywhere constitutes the connecting medium between the membranes and the surrounding parts, and which is traversed by an infinity of vessels.

This tissue is possessed of considerable elasticity, and its extensibility is so great, that in true aneurism, in varicose veins, in dilatation of the cavities of the heart, and in that variety of aneurism which has been described under the appellation of *internal mixed*, we find it becoming inordinately distended, without being ruptured. The same extensibility is manifested in the great dilatation of the uterine arteries and veins which takes place during pregnancy. Its powers of resistance, however, are very feeble. It is remarkably fragile, and it frequently gives way under very slight force.

The moisture which constantly exists upon the internal surface of the lining membrane of the vessels, and which has been regarded by some as the result of a secretory process, and by others as dependent upon the serum of the blood, is probably merely an exhalation from the capillary ramifications which are distributed to the tunics of the vessels, similar to that which takes place from all the serous surfaces.

The arteries, while they constitute the proper instruments for the transmission of the blood, are themselves abundantly supplied with minute blood-vessels denominated *vasa vasorum*. They are exceedingly small, and probably, in all cases, derive their origin from some other artery than that which they are intended to supply. They plunge at first into the cellular tunic, in which they ramify extensively, the ramusculi being distributed for the most part in radiated series. Many of them are also distributed upon the fibrous tunic, and reach the delicate cel-

lular tissue by which it is united to the lining membrane, where they form a very fine vascular plexus, which is particularly manifest when the vessel is inflamed. The veins follow the course of the arteries, and according to MASCAGNI and others, lymphatic vessels also exist as a constituent part of the coats of the blood-vessels.

The arteries are likewise supplied with nerves. These are derived, for the most part, from the ganglionic system, and are particularly abundant within the splanchnic cavities, where they twine around the vessels, and form an intricate plexus. The filaments of these nerves also twine upon the tunics of the arteries beyond the mere vicinity of their origin, and can be traced following them far into the substance of the organs. It is indeed highly probable, that they accompany the blood-vessels to their terminations, and exercise an important control over the acts of circulation, nutrition, secretion, exhalation, &c., in all of which acts, the vessels are directly concerned. They have been traced even into the bones of the extremities, following accurately the course of the arteries, and terminating with them upon the delicate medullary membrane. TIEDEMANN, moreover, found them very large upon the arteries of the penis of the horse. The arteries receive, besides, filaments from the cerebro-spinal nerves, and these, as well as the ganglionic, are distributed to both the cellular and fibrous tunics.

§ 4. *Properties of the Arteries.* One of the most remarkable properties of the arteries is their elasticity. This they possess in a high degree, in both the transverse and longitudinal direction, but it is always greatest in the latter. Hence they admit of a greater degree of distension in the direction of their length, than transversely; from which circumstance, it has been inferred by many physiologists, that during each systole of the heart, the arteries become considerably elongated, while their distension in the opposite direction is comparatively trifling. This distension, however, can only take place to a limited extent, without a rupture of the two internal tunics, which, on account of their fragility, yield very readily, and thus give rise to aneurism. It has indeed been affirmed by WINTRINGHAM (*Experimental Inquiry.* p. 182.), that the power of resistance possessed by the arteries is inferior to that of the veins, although the coats of the former are much thicker. The justice of this inference has been called in question by GORDON. (*Anatomy.* I. 57, 58.) He performed several experiments by suspending weights to different arteries. The carotid of a man sustained 30 pounds weight before it gave way: one of the iliacs sustained 48 pounds; and a transverse section of the carotid used in the first experiment, only three-fourths of an inch long, and one-eighth of an inch in breadth, was capable of sustaining 5 pounds. He also found, that air forced into the aorta, with sufficient energy to rupture its coats, required to be propelled with an impetus equal to one hundred and nine pounds. It has been supposed that elasticity is predominant in the large arteries, and contractility in the smaller ramifications.

Do the arteries possess irritability? and are they endowed with contractility, independent of that which they derive from mere elasticity? This has been affirmed and denied, by different physiologists. The negative has been advocated by HALLER, BICHAT, NYSTEN, MAGENDIE, and many other modern physiologists. The principal arguments which have been invoked in support of this side of the question are,—that mechanical and chemical irritants occasion no manifest contraction in an artery when applied directly to it; that when it is laid open and stimulated, it does not contract, so as to evert its edges, as is done by a portion of intestine under the same circumstances; that no contraction takes place when it is separated from the heart, as, for example, where a portion of the vessel is included in a ligature; that neither the direct irritation of a nerve leading to an artery, nor the influence of galvanism, gives rise to this phenomenon; and, finally, that opium, the tendency of which is to extinguish the mobility of parts endowed with irritability, exercises no influence over that of the arteries.

These arguments, together with many more which have been urged by BICHAT and others who maintain a similar opinion, are not allowed by their opponents to be valid, and most of them are positively contradicted by experiment. Hence, VAN DOEVERIN, ZIMMERMAN, VERSCHUIR, HUNTER, SOEMMERING, HASTINGS, THOMSON, Sir EVERARD HOME, and indeed a majority of modern physiologists, have maintained that the arteries are both irritable and contractile. In opposition to the first objection urged by BICHAT, it has been alleged, that although the arteries do not always contract on the application of mechanical or chemical stimuli, this effect is frequently induced. VERSCHUIR, ZIMMER-

MAN, and LORRY, saw manifest contractions induced by the application of mineral acids; THOMSON, under the irritation produced by the point of a needle, and by the volatile alkali; and WILSON PHILIP, by the rays of the sun, by gentle friction, and by alcohol: VERSCHUIR also produced contractions of the arteries by irritating them with the point of a scalpel; and in twenty-five experiments performed by HASTINGS on the different arteries of horses, dogs, cats, and rabbits, with simple mechanical irritation, ammonia, nitric acid, and the influence of atmospheric air, contraction and increased action ensued in all. (*An experimental Inquiry on Inflammation*, &c. 29. 1821.) BICHAT was also wrong in asserting that the arteries do not contract under the influence of electricity and galvanism. In the experiments of BIKKER, VAN DEN BOSCH, and VAN GEUNS, the electric spark excited manifest contractions; and the same effect was produced by galvanism, in the experiments of GIULIO and ROSSI. That these agents do not always produce contractions in the arteries, should not excite surprise, because the heart, and many muscular organs of the involuntary character, which are irritable in a high degree, frequently resist their influence. Irritation applied to the nerves which lead to an artery will sometimes occasion it to contract. This is proved by the experiment of Sir EVERARD HOME, in which the application of caustic potash to the sympathetic nerve of a rabbit, caused the carotid arteries to beat rapidly for some time.

It has been satisfactorily demonstrated, moreover, that the contractions of the arteries take place independently of the heart. Thus, the circulation has been repeatedly seen continuing for some time in animals after the removal of the heart, or where all its influence had been cut off, by the application of a ligature to the aorta. During the first periods of fœtal existence, throughout the entire uterine life of many acephalous monsters, and in some animals, the circulation is carried on perfectly, although no heart exists; and in many states of the system, as, for example, in cases of local inflammation, the arteries pulsate violently in the inflamed part, although in other situations their action is undisturbed.

All these facts prove incontestably, that the arteries are endowed with contractility, and render it probable, that they also possess irritability. It does not follow from this admission, that in this respect they are identical with muscular fibre. There may be a similarity of action in two tissues, without this being adequate to prove that there is an identity of structure, or of vital endowment. The contractility of the arteries, therefore, is probably very different from that of muscles, —and this has induced PARRY, and some others, to call it *tonicity*.

The arteries do not manifest much sensibility in their healthy state; but when they take on inflammation, they sometimes become acutely sensitive. Performing, as they do, the important office of conveying the blood to all parts of the body, their plastic forces are very strongly developed, and their powers of reproduction are possessed of great activity. Their extensive anastomosis is not the only means with which they are provided to compensate for any injury or accident they may sustain;—they are also endowed with the capability of generating new vessels.

In the performance of their office of circulating the blood, the arteries present a phenomenon which is denominated the arterial pulse. Some difference of opinion exists relative to the cause of this pulsation; some attributing it to the dilatation and contraction of the artery, while by others it is supposed that the artery is passive, and the pulsation is owing altogether to the impulse of the heart. It was long since remarked by HALLER, that the dilatation of the artery, during its pulsation, cannot be perceived by the finger, but can only be inferred. BICHAT has adopted the same view, and attributed the phenomenon of the pulse to a kind of locomotion of the artery, consisting principally in its elongation under the influence of the impulse imparted to the column of blood, by the contraction of the ventricle. PARRY has, moreover, instituted a number of experiments on living animals, with the view of settling the question, and he declares, as the result of experiments made on fifty-five of the larger arteries of horses, sheep, and dogs, that he could not discover, in a single instance, the smallest dilatation or contraction corresponding with the systole or diastole of the heart. Results of so opposite a character have been obtained by a majority of physiologists, both anterior and subsequent to the period at which PARRY made his investigations, that we may regard his inferences as completely controverted. The dilatation and contraction of the arteries have been demonstrated to possess so direct a connexion with the pulsation of the artery, that the question so long mooted may be regarded as definitively settled. The experiments of POISEUILLE, especially, who has invented an instrument of

exceeding delicacy to measure the degree to which these changes take place, are conclusive upon this point. (*Repertoire Générale d'Anatomie*, &c. VI. VII. Paris, 1829.) If, indeed, these facts were not sufficient to disprove the conclusions of Parry, a satisfactory refutation of them is furnished by various states of the circulation; as, for example, the want of harmony, as regards time between the pulsation of different arteries, and between the arteries and the systole of the ventricle; the increased pulsations of the vessels in an inflamed part, while the other arteries experience no change in their action; and various other phenomena which will be described elsewhere. (See *Circulation*, and *Pulse*.)

From what has been remarked, the pulsation of the arteries cannot with propriety be referred exclusively to any one of the conditions which have been enumerated, but is owing to the joint operation of all of them. The impulse of the ventricle, and the locomotion of the artery occasioned by its elongation, manifestly perform the most important part; but the dilatation and contraction of the artery also contribute something, and it is hence proved, contrary to the sentiment of many physiologists, that the arteries have a more important agency in the circulation of the blood, than the mere influence of their elasticity.

There are no animal structures which are more extensively influenced by age than the arteries. In young subjects, they are abundant and remarkably large, in proportion to the volume of the parts which they supply. They are also much softer, and more pliant and elastic than at a later period. As age advances, they become more compact, rigid, and fragile; some parts of them, as, for example, the arch of the aorta, become dilated and attenuated, and the whole arterial system loses much of its elasticity. Those vessels which are most dilated, frequently become divested of every indication of this property. In advanced life, their tunics, in a majority of individuals, undergo extensive calcareous or osseous transformations, and are also often the seat of a species of atheromatous degeneration, which has been particularly noted by Scarpa, as constituting the principal source of aneurisms. This earthy deposit is not formed in the lining membrane of the arteries, as represented by Meckel and a majority of pathologists, but in the delicate substratum of cellular tissue which unites it with the fibrous tunic. (See *Path. Anatomy of the Arteries.*)

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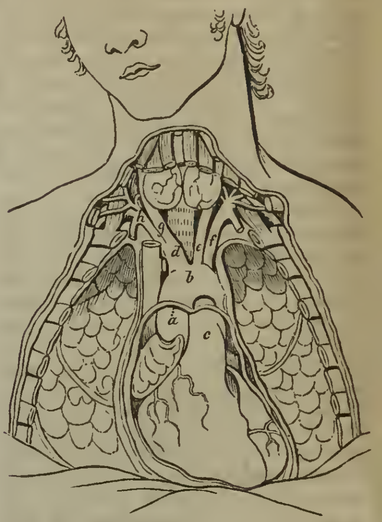
Art. II. Arteries. *Special Anatomy.* The Aorta (*Arteria Aorta*) (*Fig.* 1. *b. Fig.* 14. *b, b.*) forms the great trunk of the arterial system, through which the blood is sent from the left ventricle of the heart, to all parts of the body. From near the centre of the base of the left ventricle of the heart, it proceeds upwards, slightly forwards, and a little inclined towards the right side, placed at its origin, behind the root of the pulmonary artery (*Fig.* 1. *c.*), by which it is concealed to the extent of a few lines, and in front of the left auricle. Thus ascending in the direction of the axis of the ventricle, and behind the sternum, from which it is merely separated above by the cellular tissue which occupies the anterior mediastinum, it reaches the level of the anterior extremity of the third rib, and there changing its direction, sweeps across the anterior face of the second and third dorsal vertebra, and in front of the trachea just above where it divides into the right and left bronchi, thus forming a regular arch (*Fig.* 1. *b.*) extending from right to left, and

Fig. 1.



a, Pericardium. *b*, Arch of Aorta. *c*, Pulmonary Artery. *d*, Innominata. *e*, Left Carotid. *f*, Left Subclavian. *g*, Right Carotid. *h*, Right Subclavian.

with a slight inclination from before backwards. The aorta having reached the left side of the third dorsal vertebra, the arch is there terminated, and the vessel descends thence in nearly a perpendicular direction (*Fig.* 14. *b, b.*), in the posterior mediastinum, along the left side of the bodies of the dorsal vertebra, covered on the left side by the left pleura, and having on its right, the œsophagus, the vena azygos, and the thoracic duct. It then passes between the pillars of the diaphragm, through the *hiatus aorticus*, enters the abdomen, and continues its descent upon the bodies of the vertebra, until it reaches the level of the articulation between the fourth and fifth lumbar vertebra, where it terminates by dividing into the two primitive iliacs (*Fig.* 17. *e.*), which supply the inferior extremities and the pelvis.

The aorta has been divided into ascending, transverse, and descending portions: the first including the course of the vessel from its origin to the commencement of the arch; the second the arch itself; and the third all that portion between the termination of the arch, or the third dorsal

vertebra, and the point at which it terminates in the iliacs. It is also divided into thoracic (*aorta thoracica*) and abdominal (*aorta abdominalis*) aorta.

At its origin, the coats of the aorta are very thin, and have no direct continuity with the muscular structure of the ventricle. This latter merely overlaps the surface of the root of the vessel to a limited extent, and adheres very slightly with it. The principal attachment is formed by an adhesion which is established between the thin margin of the fibrous coat of the aorta, and a band of elastic fibrous tissue which surrounds the orifice of the ventricle, and by the lining membrane, which continues from the ventricle into the artery, and is folded upon itself to form three semilunar valves with free margins (*Fig.* 14. *a.*), which, when they are elevated from the sides of the vessel, accurately close its orifice. The portion of the aorta which corresponds to the situation of these valves is not perfectly cylindrical, but is rendered somewhat triangular, by three slight bulgings of its tunics, which form what are called the lesser sinuses of the aorta, or sinuses of Valsalva. These are natural, and are not a pathological state of the vessel, arising from a distension of its tunics occasioned by the impulse of the blood.

At its origin, the aorta is contained within the pericardium (*Fig.* 1. *a.*), and is overlapped by the pulmonary artery (*c.*), which is in front of it—and slightly by the right auricle. At about two inches or two inches and a quarter from the ventricle, it escapes from that sac, and as it ascends, has the trunk of the pulmonary artery on the left side,—the right branch of that vessel behind, the descending cava and the right lung on the right, and the sternum in front.

The transverse portion is in relation anteriorly with the sternum, from which it is merely separated by the mediastinal cellular tissue, and is crossed above by the vena innominata or left brachio-cephalic vein, which overlaps it. The concave face of the arch sweeps over the bifurcation of the pulmonary artery, with which it is connected by the remains of the *ductus arteriosus;* and posteriorly, the aorta reposes on the anterior face of the trachea a little above its bifurcation,—and towards the left side, arching over the left bronchus and the left branch of the pulmonary artery, it descends behind them, and takes its course along the left side of the bodies of the dorsal vertebra. The left pneumogastric nerve descends in front of the arch, and, on a level with its concave face, gives off the left recurrent nerve, which, passing backwards and upwards, hooks round the aorta and ascends upon its posterior face.

The aorta usually gives off five branches, between the point at which it leaves the ventricle and the termination of the arch, viz. the coronary arteries, two in number, which come off near the heart, and supply that organ; the innominata or brachio-cephalic, the left carotid (*Fig.* 1. *e.*), and the left subclavian (*Fig.* 1. *f.*). These three vessels proceed directly from the convexity of the arch, and supply the head, neck, upper extremities, and the upper part of the thorax.

The *coronary* or *cardiac arteries* (*a. coronoriæ, s. cardiacæ*) are generally two in number, rarely three (Winslow, Meckel), which are denominated right and left, from the order of their distribution.

A. The *right coronary artery* (*a. coronaria, s. cardiaca dextra, s. anterior, s. inferior*) is generally somewhat larger than the left, though in some rare instances it is smaller. It arises from the anterior part of the root of the aorta, a little to the right, and immediately above the anterior semilunar valve, but so high as not to have its orifice closed by this last. Taking its course towards the right side of the heart, it passes behind the root of the pulmonary artery, following the course of the fissure between the right ventricle and auricle, and after giving off several small ramuli, which pass off at right angles, to the pulmonary artery, the root of the aorta, the right auricle and vena cava, as well as to the fat about the base of the heart, and the base of the right ventricle, it divides into three branches, which may be denominated inferior, superior, and posterior.

a. The *inferior branch* (*ramus inferior*) takes its course downwards and forwards, and winds in a tortuous direction along the thin margin of the heart, sending off ramuli on each side to the substance of the ventricle, and finally terminating at the apex of the heart by anastomosing freely with the posterior branch, and with the branches of the left coronary.

There is generally a smaller inferior branch, which comes off higher up, and descends in a perpendicular direction upon the anterior face of the ventricle, anastomosing on the one hand with the left coronary artery, and on the other with the proper inferior branch of the right.

b. The *superior branch* (*ramus superior, s. circumflexus coronariæ dextræ*)

twines round the base of the heart, lodged in the right auriculo-ventricular fissure, until it reaches a similar branch from the left coronary. In this course, several ramuli are distributed upwards to the right auricle, and downwards to the walls of the corresponding ventricle.

c. The *posterior branch* (*ramus posterior, s. septi ventriculorum posterior*) descends upon the posterior face of the heart, following accurately the groove which corresponds to the posterior part of the septum of the ventricles, and finally terminates at the apex of the ventricles, by anastomosing with the inferior branch, and with the left coronary. In its course, it sends numerous ramuli to the walls of the right and left ventricles and the septum cordis.

B. *Left coronary* or *cardiac artery.* (*A. coronaria, s. cardiaca sinistra, s. posterior, s. superior.*) This artery is generally smaller than the preceding, and takes its origin from the anterior left side of the root of the aorta, two or three lines higher up, above the free margin of the left semilunar valve. It takes its course towards the left side of the heart, between the aorta and pulmonary artery, and in the fissure between the left ventricle and auricle, and is overlapped by the tip of the latter. After giving off small ramusculi to the aorta, the pulmonary artery, left auricle and left ventricle, it divides into two principal branches,—one posterior, which follows the auriculo-ventricular fissure; the other, anterior or descending, which follows the groove corresponding to the septum of the ventricles.

a. The *posterior* or *circumflex branch* (*ramus posterior, s. circumflexus coronariæ sinistræ*) twines round the base of the heart, in the fissure between the left ventricle and left auricle, sending numerous ramuli to the muscular walls of both these cavities, and terminates posteriorly by anastomosing with the terminal ramuli of the circumflex branch of the right coronary artery.

b. The *anterior* or *descending branch* (*ramus anterior, s. inferior, s. descendens*) descends in a tortuous direction upon the anterior face of the heart, following the groove which corresponds to the anterior part of the septum of the ventricles. It distributes numerous ramuli in its course to the right and left ventricles, and to the septum cordis, and having reached the apex of the heart, terminates by anastomosing with the right coronary. Near its origin, this branch generally gives off a ramulus which descends along the thick margin of the left ventricle, and distributes numerous ramifications upon its surface. The left coronary artery, and sometimes the aorta itself, also gives off a branch to the septum of the ventricle, through which it ramifies to the apex of the heart.

Varieties. Thebesius saw only one coronary artery coming from the aorta, which divided into two branches. (*Diss. de circ. sang. in corde.* Lugd. Bat. 1716.) Green has reported a case of the same kind (*Varieties of the Arterial System.* Tab. 1. Fig. 3.), and a third has been reported by Thomson. (*Edinb. Med. and Surg. Journal*, for April, 1835. p. 288. The existence of three coronary arteries has been witnessed by Winslow (*Exposition Anatomique.* Paris, 1732. p. 366.), and by Fiorati (*Atti della Academia di Padoua.* III. 58. P. 1.). Meckel, in one case, observed four; but the two supernumerary vessels were small, and presented the appearance of branches of the coronary arteries prematurely given off. (*Manuel d'Anat.* II. 314.) Barclay saw the right coronary terminating before it reached the septum cordis, and the circumflex branch of the left, unusually large, going round to supply its place. (*A Description of the Arteries*, &c. p. 6. Edinb. 1812.)

C. *Innominata* or *brachio-cephalic artery* (*Fig.* 1. *d.*). (*Arteria innominata, s. anonyma, s. brachio-cephalica.*) This is the first, and by far the largest, of the three branches given off by the arch of the aorta. It takes its origin from the convexity of the arch, at the point of junction between the ascending and transverse portion, and on a level with the point of union of the cartilage of the second rib with the sternum. It mounts upwards and a little outwards, behind the sternum and the sterno-clavicular articulation, and, at about an inch or an inch and a quarter, in some rare instances (Burns) two inches from its origin, divides into the right carotid (*Fig.* 1. *g.*) and the right subclavian (*h.*) arteries, the first of which supplies the right side of the head and face, while the second sends its branches to the right upper extremity, and to a part of the corresponding side of the neck and the upper part of the thorax. It is situated somewhat further forward than the other branches given off from the arch, in consequence of the slight obliquity of the latter from before backwards, and from right to left.

In front, the innominata is separated from the sternum by the sterno-thyroideus and sterno-hyoideus muscles, and by the vena innominata, or transverse vein of

the neck, which crosses it in a transverse direction. Its terminal portion is also situated directly behind the sterno-clavicular articulation. Behind, it reposes upon the trachea, which is slightly to the left of it, and between it and the vertebral column are the longus colli muscle and the sympathetic nerve. On its right side, is the right brachio-cephalic vein, and on the left, the remains of the thymus gland. Under ordinary circumstances, the innominata gives off no branches between its origin and where it divides into the right carotid and right subclavian; but not unfrequently, other branches, which generally take their origin elsewhere, proceed from it.

The left carotid arises from the convexity of the arch of the aorta, immediately beyond the innominata, and near to it. Its course is upwards and slightly outwards, behind the sternum, the left brachio-cephalic vein, the sterno-thyroideus and sterno-hyoideus muscles, and the left sterno-clavicular articulation, where it emerges in the neck. Posteriorly and internally, it is in relation with the trachea; with which it is in contact. The next in order is the left subclavian, which also takes its origin singly from the arch, still more profoundly than the preceding, and farther from the median line. It is very deeply seated at first, and is covered for some distance from its origin by the tip of the right lung, but ascending almost perpendicularly to the level of the first rib, it there becomes more superficial, and takes its course obliquely outwards over the surface of that bone.

Varieties of the ascending aorta and its arch. Departures of the aorta from the arrangement described above, are not unfrequent. A singular variety of this kind is one described by Haller and Klint. The aorta formed no arch, but immediately after its separation from the left ventricle, divided into an ascending and a descending branch. This distribution is natural in many animals. (Tiedemann. Tab. *Art.* tab. ii. fig. 3.) Hommel has described a variety of the aorta not less remarkable. That vessel divided at the commencement of the arch, into an anterior and a posterior portion, which, after passing a short distance, again united into a single trunk. The trachea and œsophagus passed through the opening formed by this arrangement of the vessel. (*Ibid.* tab. iv. fig. 6.) Two other examples of this kind have been observed,—one by Malacarne, the other by Bertin. In a case described by Malacarne, the aorta, at its origin from the left ventricle, divided into two great trunks, one situated upon the right, the other on the left side. In the mouth of the vessel there were five capacious semilunar valves, and each trunk, as it ascended, inclined inwards towards its fellow, and they united above, to form the descending aorta, which immediately inclined downwards, and pursued its usual course. From each of the ascending trunks, three branches were given off, the first of which was the subclavian, the second the external carotid, and the third the internal carotid. (*Ibid.* tab. iv. fig. 7.) Tiedemann has described a very singular anomaly of the aorta. It took its origin from the arterial portion of the heart, by a trunk which was common to it and the pulmonary artery. This trunk, after ascending slightly, gave origin, on the right side, to a large branch, which ascended, and curved outwards. This branch furnished in succession, the left carotid, the right carotid, and right subclavian. The pulmonary arteries took their origin from the posterior part of the main trunk, a little higher up, and were distributed as usual. The trunk, a little above this point, became very much contracted, but immediately after resumed nearly its former calibre, curved downwards, and became the descending aorta. From its curve, the left subclavian was given off. (*Zeitschrift für Physiologie.* Bde. IV. h. 2.; and *Lond. Med. Gazette*, II. 704. 1834.)

A variation from the natural type of the arterial system, somewhat different from either of those described, is that in which the aorta takes its origin from the right ventricle of the heart, and the pulmonary artery from the left. Cases presenting modifications of this condition have been described by Baillie, Farre, Langstaff, Wistar, Bock, Fleischmann, Meckel, Tiedemann, D'Alton, Burkart, Dugés, and Jacobson. In the case reported by Jacobson, the septum of the ventricles was perforated by a small opening situated immediately below the origin of the aorta, and the pulmonary artery was preternaturally small, the bronchial arteries being at the same time very much dilated. (Meckel's *Archives für Physiologie.* II. 134.) In Wistar's case, the ductus arteriosus was closed.

Sometimes the aorta arises directly over the interventricular septum, so as to communicate with both those cavities.

In some instances, the aorta passes over the right bronchus. (Meckel.) It occasionally passes behind the trachea and œsophagus, to reach the left side (Abernethy, Klinkosch, Fiorati, Sandifort,

Obet, Legallois, Rudolphi, Breschet, Otto, Caillot, Meckel); and instances occur, in which it descends to the lower part of the thorax on the right side of the spine. (Meckel.) A still greater displacement is that in which its direction becomes transposed,—the arch passing from left to right.

Anomalies of the descending aorta. Besides the anomalies in the position of the descending aorta described above, that vessel sometimes divides higher up than usual, into the two primitive iliacs, and these latter, before subdividing, have been seen communicating by a transverse branch. (Petsche, Meckel.) Huber has described an example, in which the thoracic aorta, on a level with the seventh dorsal vertebra, sent an accessory pulmonary artery to the right lung. A similar case has been published by Maugars, but still more remarkable in its character. An accessory pulmonary artery was given off by the abdominal aorta, which took its course upwards, perforated the diaphragm, and after supplying the phrenic artery, divided into two branches, one of which was distributed to the lower part of each lung. In an analogous case, observed by Meckel, a vessel four lines in diameter, took its origin from the anterior left part of the aorta, about half an inch above where it traverses the diaphragm. This vessel inclined a little to the left side, then descended about half an inch, and divided into two branches, which plunged directly into the lower surface of the inferior lobe of the left lung. (*Archives für Physiologie.* VI. 453. tab. iii.)

Varieties of the branches proceeding from the arch of the aorta. Anomalies in the origin of the branches from the arch of the aorta are so numerous, as to render it impracticable to specify particular examples. The number of the branches furnished by the arch may be diminished or increased, or the origin of one or more of them may be misplaced. The increase, as has been remarked by Meckel, is more frequent than the diminution.

The most frequent mode of diminution is that in which the innominata, besides the right carotid and right subclavian, gives off the left carotid, which under such circumstances, crosses obliquely in front of the lower part of the trachea. Another variety belonging to the same class, is that in which the left carotid and subclavian arise by a common trunk, like the innominata. (Malacarne, in two instances; Biumi, Tiedemann.) Tiedemann describes a case in which the first branch was the right carotid, the second a common trunk for the left carotid and subclavian, while the right subclavian originated from the descending thoracic aorta, and mounted obliquely upwards behind its ascending portion, to reach its point of destination. (Tab. II. fig. 6.) Sometimes the right subclavian arises singly from the arch of the aorta,—the two carotids and the left subclavian, from the innominata (Zagorsky); and a case is described in which the right subclavian, and right and left carotids, had a common origin, while the left subclavian and left vertebral were given off separately by the arch. The most frequent mode of multiplication is that in which the vertebral artery arises from the arch. With this anomaly is often associated the origin of the left carotid from the innominata. Next to this in frequency, is the origin of the inferior thyroid, or an accessory thyroid, from the arch. This anomaly, signalized by Neubaur, we have often observed. Sometimes both vertebral arteries proceed from the aorta, and occasionally a thymic artery has a similar origin. The same is also true of the internal mammary and the superior intercostal. These anomalies may be combined in various ways, or one or more of them may coexist; but in no case does the number of branches arising from the arch exceed six.

The anomalies in the situation of the origin of the three trunks which naturally proceed from the arch, may be referred either to the fusion of two or more of them which should be separate; the separation of the innominata into two vessels, as when the branches which it should furnish arise separately from the arch, and the transposition of one or more of them. Some of these varieties have been described above. Thus the innominata is sometimes situated on the left side. The right subclavian may come off between the right and left carotid; it may arise between the left carotid and the left subclavian, or it may be the last branch proceeding from the arch. In either of these cases, it generally crosses the neck between the trachea and œsophagus, to reach the right side. Sometimes, indeed, it arises from the descending aorta, and ranges obliquely upwards towards the right side, behind the right bronchus and the ascending aorta. (Tiedemann, Green.) In some instances, on the contrary, the left subclavian arises on the right side, and is the first branch furnished by the arch. In other cases, the left carotid is the first branch, the right carotid the second, and the two subclavians the last. Slighter degrees of anomaly consist in

the near approach or removal of the origin of the several vessels, to or from each other.

These are the most important anomalies which take place at the arch. They sometimes, however, present combinations, which it would require too much space to describe in this place. It is worthy of remark, that many of these anomalies represent the natural type of the arterial system in some animals. (See TIEDEMANN. Tab. *Arteriarum.* tab. ii. iii. iv. Carlsruhæ, 1822.)

Fig. 2.

a, Common Carotid. *b*, Division of the Common Carotid. *c*, External Carotid. *d*, Superior Thyroid. *e*, Lingual. *f*, Facial. *g*, Occipital. *h*, Posterior Auricular. *i*, Superficial Temporal. *k*, Transversalis Faciei. *l*, Internal Carotid. *m*, Right Subclavian. *n*, Inferior Thyroid. *o*, Ascending Cervical. *p*, Superficial Cervical. *q*, Superficial Scapular. *r*, Transversalis Colli. *s*, *t*, Axillary Artery. *u*, Thoracico Acromialis. *v*, Thoracicus Supremis. *w*, Thoracicus Longus. *x*, Subscapularis. *z*, Occipital.

D. The common or primitive carotid arteries (*Fig.* 1. *e*, *g*. *Fig.* 2. *a.*) (*arteriæ carotides communes s. primitivæ*) present some difference on the right and the left sides. The right arises from the innominata, as previously stated; the left from the arch of the aorta. The former is, therefore, somewhat shorter, more superficial, and a little more oblique in its course, than the latter, which is deep-seated at its origin, and ascends more perpendicularly. In other respects, the description of one will apply to the other.

The common carotid artery ascends from its origin, by the side of the trachea and larynx, and in front of the roots of the transverse processes of the cervical vertebra; but in consequence of the artery on the right, and that on the left side, gradually receding from each other as they advance upwards, they are farther separated above than they are below. It likewise presents the appearance of advancing backwards, or, as it were, retreating, so as to become more profound in the upper than in the lower part of the neck. But this is in reality not the case; the appearance in question merely results from the great projection forwards of the larynx and os hyoides in the upper part of the cervical region. The artery, indeed, follows the anterior face of the vertebral column, until it reaches the level of the superior margin of the thyroid cartilage, or the space between it and the horn of the os hyoides (*Fig.* 2. *b.*), where it divides into the internal and external carotid arteries;—the first of which is destined to supply a part of the brain and the eye, while the second is distributed to the superficial parts of the neck, face, and head. Between its origin and the point at which it divides, the common carotid gives off no branches, except some very minute ramusculi which are seldom apparent.

The carotid is covered in the lower part of the neck, by the skin, platysma myoides, and cervical fascia, the sterno-cleido-mastoideus, sterno-hyoideus, and sterno-thyroideus muscles. Near the level of the inferior margin of the cricoid cartilage, it is crossed obliquely by the omo-hyoideus, and in the upper part of the neck, the descending branch of the ninth pair of nerves courses along upon the anterior part of its sheath,—sometimes, indeed, contained within it. In this latter situation, in consequence of the inclination of the sterno-cleido-mastoideus muscle backwards, the artery is no longer covered by it, but is placed directly beneath the skin, platysma myoides, and cervical fascia, and can consequently be much easier reached above the point at which it is crossed by the omohyoideus, than lower down.

Internally, the common carotid is in relation with the trachea, the thyroid gland, which generally overlaps it, and the larynx; and on the left side, likewise with the œsophagus, in consequence of the inclination of that tube to the left of the median line. When both carotids are given off by the innominata, they generally run, near their origin, obliquely upon the lower part of the trachea, especially the right, so that in the operation of bronchotomy, the artery might be wounded in attempting to open that tube. The left carotid is, besides, crossed near its origin by the left brachio-cephalic vein. Posteriorly, the artery is in relation with the

spine, from which it is separated by the longus colli, and the rectus capitis anticus major muscle. There are, moreover, interposed between it and the vertebral column, in the lower part of the neck, the recurrent nerve and the inferior thyroid artery; and on the left side, besides these, the thoracic duct:—throughout the whole extent of the artery, the cervical portion of the great sympathetic nerve is directly behind the vessel, but is not included in the same sheath. Externally, the internal jugular vein runs parallel with the artery, and when distended, overlaps it. The pneumogastric nerve also courses along its outer side, but is somewhat deeper seated, and is contained in the posterior portion of the strong sheath, which invests it, in common with the artery and the jugular vein.

E. *External carotid artery.* (*Ramus carotis externus, s. cephalicus externus.*) (*Fig.* 2. *c.*) This branch, which is distributed to a part of the neck, to the face, and the superficial parts of the head, is, in the fœtus, where the brain is relatively very voluminous, much smaller than the internal carotid; but in the adult it equals that vessel in size, and in some instances is even larger. At the point at which the common carotid bifurcates, the two branches repose in contact; but as the internal forms a slight convexity forwards at its origin, it is generally most superficial at first, but after ascending a small distance, becomes deeper seated than the other. The external carotid advances upwards and a little backwards, becoming at the same time somewhat deeper, from the level of the upper margin of the thyroid cartilage, passing first beneath the hypoglossal nerve, and the stylo-hyoid and disgastric muscle,—then through the substance of the parotid gland between the angle of the jaw and the ear, until it reaches the vicinity of the neck of the inferior maxillary bone, where it divides into two branches,—the internal maxillary (*Fig.* 5. *a.*), and the temporal (*Fig.* 2. *i.*).

In the first part of this course it is superficial, and is merely covered by the skin, platysma myoides, and cervical fascia: higher up it is crossed in front by the hypoglossal nerve, the stylo-hyoideus, and the posterior belly of the digastricus; and above this point, it plunges into the substance of the parotid gland, in which it is still embedded where it divides. Internally, it is in relation with the pharyngeal plexus of nerves, the stylo-glossus and stylo-pharyngeus muscles, and the glosso-pharyngeal nerve, which separate it from the internal carotid.

In its course, the external carotid gives off several branches, which may be divided into anterior, internal, and posterior. The anterior are, the superior thyroid, the lingual, and the facial: internally, it furnishes the ascending or inferior pharyngeal, and posteriorly, the occipital and posterior auricular.

a. The *superior thyroid artery* (*Fig.* 2. *d.*) (*ramulus thyroideus superior*) is the first branch given off by the external carotid artery. It arises from the anterior part of that vessel near the bifurcation, and sometimes even from the common carotid. It advances at first upwards and forwards, then, forming a curve, the convexity of which is directed upwards and towards the larynx or os hyoides, it takes its course downwards and inwards towards the thyroid gland, into the upper portion of which its numerous ramusculi plunge, and form an intricate anastomosis with those of the corresponding artery of the opposite side, and with those of the inferior thyroid. In this course, the artery is covered by the skin, platysma, and cervical fascia,—is accompanied by the superior laryngeal nerve, which is deeper seated, and furnishes the following ramusculi:

α. *R. hyoideus, s. sterno-cleido-mastoideus.* This is generally a small branch, which is given off near the origin of the artery, and which immediately divides into two ramifications. The first takes its course directly forwards, below the horn of the os hyoides, to anastomose with a similar vessel of the opposite side, and to send minute ramifications into the thyro-hyoid ligament, to the muscle of the same name, and to the other adjacent structures. The other winds its way downwards and outwards across the front of the common carotid artery, and is principally spent upon the sterno-cleido-mastoideus muscle. This ramification is generally divided in exposing the carotid artery to apply a ligature.

β. *R. laryngæus.* This branch sometimes comes off in common with the preceding, and in some instances even from the common carotid. It advances forwards and inwards, in company with the superior laryngeal nerve, sends small branches to the thyro-hyoid and omo-hyoid muscles, and having reached the upper part of the larynx, penetrates ordinarily above the margin of the thyroid cartilage, and between it and the horn of the os hyoides, by perforating the broad thyro-hyoid ligament,—sometimes through a special opening in the thyroid cartilage itself, and more rarely through the ligament which fills up the space between the thyroid and

cricoid cartilages. When this latter distribution exists, it anastomoses with a similar branch from the opposite side, upon the surface of the ligament, where, being superficially situated, it may be divided in the operation of laryngotomy; and even in those cases in which the artery enters the larynx at the first or second points, it generally sends off a small crico-thyroid branch, which traverses the same ligament. The terminal ramifications of the laryngeal branch, are distributed to the mucous membrane, the upper part of the epiglottis, and to the small muscles of the larynx. One sometimes passes outwards to the thyro-hyoideus muscle.

b. *Lingual Artery.* (*Fig.* 2. *e. Fig.* 3. *a.*) (*Ramulus lingualis.*) This branch, which is sometimes larger than the last described, takes its origin from the anterior part of the external carotid (*Fig.* 3. *d.*), a little higher up, and somewhat more profoundly. It advances forwards, inwards, and a little upwards, above the horn of the os hyoides, and below the hypoglossal nerve, with which it runs parallel. It there glides between the hyoglossus muscle and the middle constrictor of the pharynx, changes its direction, and ascends in nearly a perpendicular course, until it becomes fairly engaged in the tongue, where it again resumes the horizontal direction, and advances forwards under the name of the *ranine* artery, along the lower surface of the tongue, between the genio-glossus and lingualis, accompanied by the lingual nerve, and finally terminates at the tip of that organ, by anastomosing in form of an arch with the corresponding branch of the opposite side.

Fig. 3.

a, Lingual Artery. *b*, Ranine. *c*, Sublingual. *d*, External Carotid. *e*, Dorsalis Linguæ.

In this course, the lingual artery gives off several branches: 1. Small ramusculi to the hyo-glossus, the middle constrictor, and the submaxillary gland. 2. The hyoid branch (*ramus hyoideus*), which comes off behind the hyo-glossus muscle, and descending downwards and inwards between the genio-glossus and genio-hyoideus, distributes ramifications to these muscles, and terminates at the os hyoides, by anastomosing with the branch of the opposite side. 3. From one to three or four small branches (*ramuli dorsales linguæ. Fig.* 3. *e.*) from the ascending or perpendicular portion of the artery, which advance towards the root of the tongue, beneath the hyoglossus muscle, sending ramifications to it, to the epiglottis, tonsils, and palate. 4. The lingual artery beyond this point, divides into the ranine (*Fig.* 3. *b.*) and sublingual (*Fig.* 3. *c.*) branches, the first of which is distributed along the lower surface of the tongue, as far as its tip, being merely covered by the mucous membrane, and placed immediately by the side of the frenum, where it may be wounded in dividing that band. The second, or *sublingual*, which is sometimes furnished by the submental branch of the facial, is situated further outwards. It advances horizontally forwards, between the genio-hyoideus and the sublingual gland, sending numerous ramifications to both, and finally perforates the mylo-hyoideus muscle, and is expended upon it and the digastricus, forming at the same time a free anastomosis with the submental branch of the facial.

From these various sources, the tongue receives an abundant supply of vessels, which ramify minutely through its substance, and anastomose with those of the opposite side.

c. *Facial*, or *External Maxillary Artery.* (*Figs.* 2, 4, 5. *f.*) (*Ramulus facialis, s. maxillaris externus. Palato-labiale,* Chauss.) This branch takes its origin from the carotid, higher than the lingual, and is frequently somewhat larger than that vessel, though in many instances it is smaller, and does not reach the whole of its points of destination. In such cases, the parts of the face which are not supplied by it, receive branches from the transverse facial. The course of the facial artery is at first upwards and slightly forwards, along the side of the pharynx, and beneath the stylo-hyoideus and the posterior belly of the digastricus muscles. Having reached this point, it plunges beneath the submaxillary gland, becomes profoundly embedded between that body and the inferior part of the lower jaw bone, and from thence glides obliquely outwards, along the upper surface of the gland, and beneath the margin of the bone, over the surface of which it twines, to mount upon the face, where it is superficial, and can be easily felt pulsating upon the surface of the inferior maxillary bone, and immediately in front of the edge of the masseter muscle. From this situation, it glides obliquely upwards and forwards, reposing for some distance upon the buccinator muscle, and having reached

the angle of the mouth, passes beneath the lower part of the zygomatic, and levator muscle of the angle of the mouth, ascends by the side of the nose, and after sending numerous ramusculi to the various parts situated in its course, terminates near the inner angle of the eye, by forming a free anastomosis with the branches of the ophthalmic artery.

The branches given off in this transit of the facial artery, may be divided into two orders:—those which proceed from the vessel before it twines over the surface of the jaw, and those which arise from it while pursuing its tortuous course along the face.

α. *R. palatinus inferior*, *s. adscendens.* This branch not unfrequently comes off from the inferior pharyngeal, or even the carotid. It usually arises from the facial, a few lines from the external carotid, and mounts upwards between the stylo-pharyngeus and stylo-glossus muscles, sending off small ramusculi in its course to the pharynx and adjacent parts, and is distributed to the tonsils, eustachian tube, and soft palate. There is one small ramusculus especially, which, separating from the rest near the levator palati mollis, follows the course of the circumflexus palati, ramifying extensively in the velum of the palate and the uvula, and anastomosing freely with a similar branch from the opposite side.

β. *R. musculares*, variable in number and size, are distributed to the disgastric, styloid, and pterygoid muscles; some of them are likewise expended upon the pharynx.

γ. The *r. tonsillaris* is a small branch, which ascends in the vicinity of the stylo-glossus muscle near its termination, and distributes its ramifications to the tonsil, and the adjacent portion of the same side of the tongue.

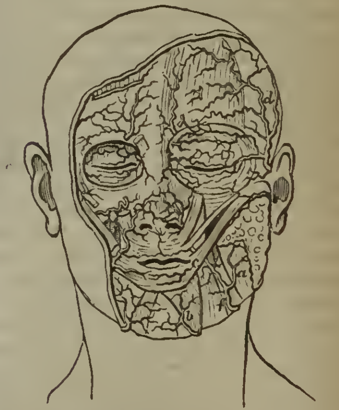
δ. *R. glandulares* are four or five small branches which plunge directly into the submaxillary gland and ramify through its substance, most of them terminating in its granular structure, while a few extend to the adjacent muscles.

ε. *R. submentalis* (*Fig.* 4. *b.*) is an important branch of the facial. It usually arises from that vessel where it is about to emerge from between the lower jaw and the submaxillary gland. Taking its course forwards, it glides along the surface of the mylo-hyoid muscle, nearly in contact with the internal part of the lower margin of the jaw, and above the anterior belly of the digastric muscle. Having arrived near the chin, it usually divides into two branches, one of which sends ramifications into the digastric, mylo-hyoideus, genio-hyoideus, and genio-glossus muscles, and anastomoses with the ramifications from the opposite side, as well as with the hyoid branch of the lingual artery. The other mounts upon the chin (*b.*), anastomoses with a small branch of the inferior dental which escapes from the bone through the mental foramen, and after ramifying minutely in the integuments and muscles of the chin and lower lip, ends by anastomosing extensively with the ramifications of the inferior labial or coronary. In this course, the submental ramusculus sends ramifications to the submaxillary gland, to the adjacent muscles, and to several lymphatic glands which repose in contact with it. It also, in some instances, where the lingual artery is small, supplies the ranine branch to the tongue.

The branches sent off by the facial, after it has ascended above the margin of the lower jaw, are,

ζ. *R. masseteres* (*Fig.* 4. *a.*), consisting of one or more small branches which come off posteriorly, where the artery is coursing over the surface of the bone, and, ascending upwards and backwards, ramify in the masseter, buccinator, and platysma myoides muscles, and in the cellular tissue and fat of the face, the parotid gland, and other adjacent parts. They anastomose with the ramifications of the temporal.

Fig. 4.



a, Maseteres. *b*, Submental. *d*, Anterior Superficial Temporal. *f*, Facial. *c* Inferior Labial. *e* Supra Orbital.

η. *R. labialis inferior*, vel *superficialis.* This ramusculus usually arises somewhat lower than the preceding, from the anterior part of the facial artery, and sometimes from the inferior coronary. It advances forwards, and ramifies exten-

sively in the substance of the lower lip, where it anastomoses with the submental, the dental, and the inferior coronary of the lip.

ϑ. *R. coronarius labii inferior.* (*Fig.* 4. *c.*) The facial artery, pursuing a serpentine course towards the angle of the mouth, divides about midway between the lower jaw and the point just mentioned, into two branches, one of which preserves the original direction of the vessel;—the other, the inferior coronary, advancing forwards, glides beneath the depressor anguli oris, and winds in a tortuous direction through the substance of the lower lip, a little exterior to the mucous membrane of the mouth, and sends numerous ramusculi to the orbicular and depressor muscles, and to the integuments of the lip and chin. It forms a free anastomosis with its fellow of the opposite side, as well as with the superficial inferior labial, when it exists, and with the dental and submental branches.

ι. *R. coronarius labii superior.* (*Fig.* 4. *g.*) This branch, which is larger and more tortuous than the preceding, separates from the facial opposite the angle of the mouth, glides beneath the zygomatic and levator muscles, and plunges into the substance of the upper lip, along the margin of which it winds its tortuous course, sending ramifications to the orbicular muscle, the several elevators, to the mucous membrane of the mouth, and finally terminates by anastomosing with the artery of the opposite side. Near its termination, it sends one or more small ramusculi upwards (*r. septi nasalis*), which ascend in a perpendicular direction towards the septum of the nose, along which they ramify, and terminate near the tip, by a free anastomosis. The superior labial, likewise, sometimes gives off the *r. pinnalis*, to the ala of the nose; but this branch more frequently arises from the facial.

Both the coronary arteries are tortuous, because of the great mobility of the parts to which they are distributed. They are, moreover, exceedingly variable in their origin and distribution. One or both of them sometimes come from the transverse facial, and in such cases, the proper facial is smaller than usual. The inferior is not unfrequently wanting, its place being supplied by the ramusculi of the submental, the dental, or the inferior superficial labial.

κ. *R. lateralis nasi, s. pinnali* (*Fig.* 4), are small ramifications given off by the facial a few lines higher up, where it is covered by the levator labii superioris et alæ nasi. They are distributed extensively upon the ala and dorsum of the nose, where they form a kind of plexus by anastomosing with their congeners of the opposite side. Some of them are occasionally denominated *r. dorsales nasi.* The facial then ascends between the two attachments of the levator labii superioris et alæ nasi, anastomoses with the ramifications of the infra-orbital, sends branches to the lower eye-lid, ascends by the internal angle of the eye, and terminates by anastomosing with the ramifications of the nasal and supra-orbital branches of the ophthalmic, and by distributing small ramusculi to the lachrymal sac and the orbicular muscle of the eye-lids.

The ramifications of this artery upon the face are exceedingly numerous, and form an intricate plexus throughout nearly the whole facial region, as well by the frequency of their communications with each other, as through their anastomosis with the transverse facial, the infra-orbital, and inferior dental of the internal maxillary,—and the ophthalmic branch of the internal carotid.

d. The *inferior pharyngeal artery* (*r. pharyngeus inferior, s. ascendens*) is the only branch given off by the carotid internally, and is the smallest of the branches which take their origin from that vessel. It is profoundly situated, and usually proceeds from the external carotid near the origin of the lingual or facial,—sometimes by a common origin with one of those vessels, and occasionally from the bifurcation of the common carotid. It ascends, covered at first by the stylo-pharyngeus muscle, between the internal and external carotids, by the side of the pharynx, and in front of the anterior rectus muscle of the head. In its course, it sends off numerous ramusculi to the adjacent parts:

α. *R. pharyngeii*, generally three in number, distributed inwards;—the two inferior, to the corresponding constrictors of the pharynx, through which they ramify to reach the mucous membrane, and to the stylo-pharyngeus muscle; the superior, to the upper constrictor, the eustachian tube, arches of the palate, tonsils, and even the posterior part of the nares.

β. *R. externes, s. cervicales.* These are small and irregular. They are expended mostly upon the superior cervical ganglion of the sympathetic, the pneumogastric, hypoglossal and spinal accessory nerves,—the deep-seated muscles of the neck, and the lymphatic glands.

γ. *R. meningeii*, consisting of numerous

ramusculi of variable size, which are distributed to the base of the cranium, the dura mater, and other adjacent parts. One of these, larger than the others (*r. meningeus posterior*), accompanies the internal jugular vein to the posterior foramen lacerum, through which it passes, between the vein and the pneumo-gastric nerve, to supply the dura mater in that part of the skull. Sometimes it traverses the bone by a separate foramen situated near the mastoid process. Another ramusculus traverses the base of the cranium by the anterior foramen lacerum, or the irregular opening formed by the rough extremity of the petrous portion of the temporal bone and the body of the sphenoid, to supply the dura mater in the vicinity of the sella turcica. There are, besides, some other small ramifications expended mostly upon the bones and the dura mater. One of these passes through the anterior condyloid foramen, to the parts within the cranium.

e. The *occipital artery* (*Fig.* 2. *g*, *z.*) *r. occipitalis*) is the first and largest of the branches given off by the external carotid posteriorly; but is smaller than either the lingual or facial, nearly opposite to which it takes its origin. It courses backwards and upwards, below, and parallel with the posterior belly of the digastric muscle, in front of the internal jugular vein, the pneumogastric, spinal accessory, and hypoglossal nerves, the latter of which hooks around it to take its course towards the tongue. It then glides beneath the upper part of the sterno-cleido-mastoideus muscle, over the surface of the rectus capitis lateralis, and in the space between the transverse process of the atlas and the mastoid process, where it is deep-seated. Here its course is horizontal for a small distance, first beneath the trachelo-mastoideus,—afterwards beneath the complexus and splenius muscles, and again ascending, after having arrived near the inner part of the crucial ridge of the occipital bone, it perforates the cranial attachment of the splenius, and ramifies extensively upon the posterior part of the head. It furnishes the following branches:—

α. Several small ramifications to the digastric, stylo-hyoid, and sterno-cleido-mastoid muscles,—to the parotid, and lymphatic glands of the upper part of the neck.

β. A small ramusculus follows the course of the internal jugular vein, and penetrates the posterior foramen lacerum, to be distributed to the dura mater.

γ. From the same vicinity, it detaches a small posterior auricular branch, which advances upwards and forwards to the lobe of the ear; and a second, denominated *posterior temporal*, which ascends behind the ear, and is distributed to the concha.

ε. In the vicinity of the mastoid process, it sends off a mastoid branch, which traverses the foramen of the same name, to reach the posterior part of the dura mater,—small ramusculi to the rectus capitis lateralis, trachelo-mastoideus, complexus, splenius and semispinalis colli.

ζ. On a level with the transverse process of the atlas, it detaches a considerable descending branch (*r. princeps cervicis*), almost equal in size to the continuous portion of the vessel. It frequently descends for some distance upon the back, in the space between the semispinalis colli, sends ramusculi into all the adjacent muscles, and anastomoses in its course with the branches of the ascending, transverse, and profound cervicals, and, on a level with each intervertebral space, with the branches of the vertebral.

η. A small transverse branch is sent off near the occiput, which, taking its course across the recti and oblique muscles of the head, unites with its fellow of the opposite side, and forms an arch, with its concavity downwards. From this, small ramusculi are detached to the adjacent muscles.

The occipital artery, having perforated the cranial attachment of the splenius muscle, becomes superficial, and divides into several tortuous branches, which pursue an arborescent distribution over the whole of the posterior part of the head, supplying the scalp and the bone, and forming an intimate anastomois,—anteriorly, with the posterior auricular and the temporal, and posteriorly, with the occipital of the opposite side.

f. The *posterior auricular artery* (*Fig.* 2. *h.*) (*r. auricularis posterior*, *s. stylo-mastoideus*) is much smaller than the occipital, and arises from the posterior part of the external carotid a few lines higher up, a little above the level of the digastric and stylo-hyoid muscles. Sometimes it is a branch of the occipital. Concealed at its origin by the parotid gland, in the posterior part of which it is partially embedded, it advances upwards and a little backwards, between the mastoid process and the ear, and terminates by anastomosing on the side of the head with the occipital and temporal arteries. It furnishes the following ramusculi:

α. *R.* to the posterior belly of the di-

gastric muscle, and to the stylo-hyoideus and parotid gland.

β. *R. stylo-mastoideus*, which penetrates the stylo-mastoid foramen of the temporal bone, and traverses the aqueduct of Fallopius. It sends one or more branches to the membrana tympani, which, by anastomosing with a small ramusculus from the internal maxillary, forms a kind of circle around that membrane, sending minute vessels to it, to the lining membrane of the external meatus of the ear, and to the adjacent portion of the mucous membrane of the cavity of the tympanum. It likewise distributes branches to the mastoid cells, to the whole of the lining of the tympanum, to the muscles of the internal ear, and to the concha, vestibule, and semicircular canals. It finally terminates by anastomosing with a small branch of the meningeal artery, which enters the petrous portion of the temporal bone, through the *hiatus Fallopii.*

γ. The artery then ascends between the mastoid process and the ear, and divides into anterior and posterior branches. The first, which are minute, ramify upon the back part of the concha, between the integuments and the cartilage, and upon the posterior auricular muscle. The posterior branch, somewhat larger, courses over the root of the mastoid process, and distributes ramusculi to the occipital, temporal, mastoid, and splenius muscles, and to the integuments of the cranium, anastomosing on the one hand with the posterior branches of the temporal artery, and on the other with the occipital.

The external carotid artery having given off these ramuli, and reached the level of the neck of the condyle of the lower jaw, divides while yet concealed by the parotid gland, into the temporal artery, which may be regarded as the continuation of the vessel, and the internal maxillary, distributed to the deep-seated parts about the face.

g. The *superficial temporal artery.* (*Fig.* 2. *i. Fig.* 5. *b.*) (*R. temporalis superficialis.*) This branch is smaller and more superficial than the internal maxillary. It ascends in the original direction of the external carotid artery, between the articulation of the lower jaw, the external meatus of the ear, and the parotid gland, being covered by the latter, as high as the posterior root of the zygoma. At this latter point it becomes superficial, and glides in a tortuous direction beneath the anterior auricular muscle, where it reposes upon the upper branch of the root of the zygomatic process, covered by the skin and a slip of the temporal fascia, and can be conveniently compressed. It continues its course upwards upon the surface of the temporal aponeurosis, invested in a kind of sheath furnished by that structure, and a little above the zygoma, divides into anterior and posterior branches, which ramify in an arborescent manner upon the whole of the side of the head. (*Fig.* 4. *d.*) The branches furnished by the superficial temporal artery are,—

α. Small ramusculi to the parotid gland, and the structures which enter into the formation of the articulation of the lower jaw. A small branch traverses the glenoid fissure of the temporal bone, to reach the membrana tympani, where it anastomoses with a branch of the posterior auricular, and supplies that membrane, as well as the muscle of the malleus.

β. *R. massetericus superior.* The superficial temporal artery generally sends one or more small ramifications forwards to the masseter muscle, and to the integuments of the cheek, which anastomose with the branches of the labial.

γ. *R. transversalis faciei.* (*Fig.* 2. *k.*) A few lines above the division of the external carotid artery into the internal maxillary and temporal, the latter gives off the transverse facial branch, which emerges from the parotid gland by which it is at first concealed, takes its course forwards over the surface of the upper part of the masseter muscle, between the duct of the parotid gland and the zygoma. It is accompanied by two or three filaments of the facial nerve, and in its course, distributes ramusculi to the parotid and socia parotidis,—the masseter, temporal, zygomatic, and palpebral muscles, and ramifying upon the face, terminates by forming a free anastomosis with the infra-orbital, alveolar, facial, and anterior temporal arteries. It also anastomoses with some of the branches of the internal maxillary. When the facial is very small or imperfect, the superior labial, and the nasal branches of that vessel, are furnished by the transverse facial.

ζ. *R. temporalis medius, vel profundus*, likewise takes its origin from the superficial temporal, usually a little below the zygoma,—sometimes above it. Advancing obliquely upwards and forwards, it distributes small ramusculi to the masseter muscle, glides over the surface of the zygoma, and perforating the temporal aponeurosis on a level with the upper margin of that arch, ramifies extensively in the temporal muscle, and anastomoses with the deep temporal branches of the internal

maxillary:—some of its superficial ramifications likewise advance towards the angle of the eye, and anastomose with the palpebral.

ε. R. auriculares anteriores inferiores, et anteriores superiores. While the temporal artery is ascending in front of the ear, it sends several small branches backwards to the anterior and inferior part of the auricle, and to the superior portion of the same, as well as to the upper auricular muscle. They arise from the temporal in a successive series, and are denominated inferior and superior anterior auricular branches, in contradistinction to the posterior.

Having ascended above the level of the root of the zygoma, and reached the surface of the temporal muscle, the temporal artery divides into an anterior and posterior branch.

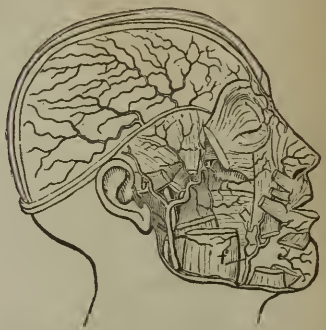
ζ. R. temporalis anterior, s. frontalis (*Fig.* 4. *d.*) pursues a tortuous course upwards and forwards towards the forehead, and spreads its arborescent ramifications over the whole of the anterior lateral part of the head. They supply the integuments of the cranium, the temporal muscle, the orbicularis palpebrarum, and the corrugator supercilii. They anastomose near the external angle of the eye, with the facial; —in the superciliary region, with the frontal and supra-orbital branches of the ophthalmic; and near the glabella, with the branches of the opposite side.

η. R. temporalis posterior, vel occipitalis. This branch, which may be regarded as the termination of the superficial temporal, mounts upwards and backwards upon the lateral and posterior part of the head. It divides into numerous ramifications, which present an arborescent arrangement. They supply the integuments of the cranium, and anastomose, anteriorly, with the anterior temporal; on the vertex, with the branches of the opposite side; and posteriorly, with the occipital and posterior auricular.

The temporal and occipital arteries, spread out as they are upon the whole superficies of the head, not only supply the whole of the soft parts which occupy this region, and form an intimate anastomosis by all their branches, but likewise distribute an infinity of minute ramusculi into the diploe of the bones, by which an intimate and important association is formed between them and the vessels within the cranium.

h. The *internal maxillary artery* (*Fig.* 5. *a.*) (*r. maxillaris internus*) is larger than the temporal. From the multiplicity of its branches and their complicated distribution, it is difficult to render them intelligible by mere description. It separates from the temporal in the substance of the parotid gland, and on a level with the neck of the condyle of the lower jaw. In its course forwards to the deep-seated parts of the face which it supplies, it is

Fig. 5.



a. Internal Maxillary. *b,* Superficial Temporal. *f,* Facial.

exceedingly tortuous, and changes its direction several times. Tracing it from its origin from the external carotid, or rather from the point at which it separates from the temporal, it may be divided into three portions, founded upon the direction pursued by it.

1. It advances downwards and inwards to sweep round the inner surface of the neck of the condyle of the lower jaw, and between it and the internal lateral ligament; —then inwards between the two pterygoid muscles, and the inferior dental and the lingual nerves, and here changing its direction again, it advances forwards towards the tuber of the superior maxillary bone, where it terminates in the second, or vertical portion. The course of this first part of the artery is nearly horizontal.

2. Having reached the pterygoid process, the internal maxillary artery ascends in nearly a perpendicular direction, between the attachments of the external pterygoid muscle, and glides between the surface of the zygomatic fossa and the attachment of the temporal muscle, until it arrives near the bottom of the orbit, where it again changes its direction.

3. Near the level of the bottom of the orbit, the artery assumes, a second time, a horizontal course, and advancing forwards and inwards, plunges into the spheno-maxillary fossa, and terminates by dividing into several branches, one of which runs forwards along the infra-orbital canal, to be distributed upon the face. The

branches given off by the internal maxillary artery may be divided into three series, according as they proceed from these three portions of the vessel.

Branches given off between the origin of the artery and the pterygoid process:

α. *R. auricularis profundus* is a small irregular ramusculus, which proceeds to the external meatus of the ear, and is distributed to it and the neighbouring parts.

β. *R. tympanicus.* This is also a small branch, which, coming off near the articulation of the lower jaw, sends minute ramusculi to that joint, and penetrates the glenoid fissure of the temporal bone, to supply the laxator tympani muscle, and the adjacent portion of the mucous membrane lining the internal ear.

γ. *R. meningeus parvus s. pterygoideus externus* is generally a small branch originating in the vicinity of the preceding,—sometimes from the great meningeal, or one of the pterygoideal branches. It advances upwards towards the base of the skull, and distributes small branches to the inferior maxillary nerve, the external pterygoid muscle, and to the circumflexus and levator palati muscles. Then entering the cranium through the foramen ovali, it supplies the dura mater in the vicinity of the sella turcica.

ζ. *R. meningeus medius s. magnus, s. spinosus.* This is a branch of considerable size. It arises from the upper part of the internal maxillary artery, and mounting directly upwards on the outer side of the internal lateral ligament of the lower jaw, and between the two pterygoid muscles, towards the foramen spinale of the sphenoid bone, it enters the cranium by that opening, and is distributed extensively to the dura mater. In its course, before it enters the cranium, it sends small branches to the pterygoid and temporal muscles; the superior constrictor of the pharynx; the eustachian tube, and the circumflex and levator muscles of the palate. A few also traverse the sphenoid bone, or pass through the anterior foramen lacerum to the dura mater at the base of the cranium. The artery then glides through the foramen spinale of the sphenoid bone, and becomes lodged in a deep furrow,—sometimes a perfect canal, on the inner side of the anterior inferior angle of the parietal bone. Within the cranium, it distributes small ramusculi to the fifth pair of nerves and the adjacent portion of the dura mater: a small branch which enters the orbit through the greater wing of the sphenoid, through the malar bone, and sometimes through the spheno-maxillary fissure, to be expended upon the lachrymal gland: a branch also penetrates the hiatus Fallopii, and traverses the aqueduct of the same name,—sending in its course ramusculi to the facial nerve, to the lining membrane of the tympanal cavity, the internal muscle of the malleus and the membrana tympani;—it finally terminates by anastomosing with the stylo-mastoid branch. The terminal portion of the middle meningeal artery consists of an anterior and a posterior ramulus, which branch out upon the internal surface of the parietal bone, and in the substance of the outer surface of the dura mater, and make a beautiful arborescent impress upon the former, represented by a number of superficial grooves, in which the ramifications are lodged. The anterior branch, directed upwards and forwards, follows the course of the coronal suture, and anastomoses in the vicinity of the longitudinal sinus with the branches of the opposite side, and, further forwards, with the ophthalmic. The posterior, in a similar manner, advances upwards and backwards, and after ramifying extensively, anastomoses with the branches of the opposite side, and with the posterior meningeal arteries furnished by the spinal and the occipital. Numerous ramusculi also penetrate the bone to supply the diploe, and others penetrate the sutures to anastomose with the vessels of the scalp.

ε. *R. maxillaris inferior, s. dentalis, s. alveolaris inferior.* The inferior dental artery generally takes its origin from the lower part of the internal maxillary, opposite the point at which the middle meningeal is given off. It advances forwards, along the inner side of the neck of the lower jaw, and between the internal surface of that bone and the internal pterygoid muscle, and enters the posterior dental foramen. Traversing the bony canal which occupies the alveolar portion of the jaw, it detaches from its upper surface small ramusculi which penetrate the fang of each tooth, to supply its pulp. Having arrived near the chin, it divides into two branches, one of which, after running a small distance, escapes through the mental foramen, and is distributed to the integuments and muscles about the chin, anastomosing above with the inferior labial, below with the submental, and on the median line with the branches of the opposite side. The other branch continues to traverse the alveolar process to the symphysis of the chin, and supplies the fangs of the incisor teeth.

Previously to entering the maxillary canal, the inferior dental artery detaches small ramusculi to the internal pterygoid, temporal, and bucciuator muscles; to the dental and lingual nerves, and the adjacent glands. Where it is about to enter the bone, it gives off a small ramification which glides along the inner surface of the lower jaw, following accurately the course of the mylo-hyoid nerve, and supplying the mylo-hyoid muscle, the mucous membrane of the floor of the mouth, and other structures in the vicinity.

Branches furnished by the vertical or ascending portion of the internal maxillary artery:

ζ. *R. temporalis profundus posterior.* This small branch arises near the last, and is concealed at first by the temporal and pterygoid muscles. It ascends covered by the latter muscle, and between it and the surface of the cranium, into the temporal fossa, where it terminates by distributing numerous ramifications to the temporal muscle and periosteum, and anastomosing anteriorly with the anterior deep temporal, and posteriorly with the branches of the middle and superficial temporals. Near its origin, it gives small branches to the pterygoid and buccinator muscles.

η. *R. pterygoideus* is a small muscular branch, which comes off near the preceding, and is sometimes a branch of it. Very generally there are several of these branches, which are exceedingly variable in size and number. They are distributed to the internal and external pterygoid, and the buccinator muscles. Some of them ascend in the temporal fossa, and follow the course of the posterior deep temporal artery.

ι. *R. massetericus*, like the preceding, is very small and irregular. It likewise arises from the internal maxillary, where it courses upwards between the pterygoid muscles. It advances outwards, through the semilunar notch of the lower jaw, sending ramifications in its course to the temporal and pterygoid muscles, and plunges into the masseter muscle, in which it ramifies very extensively. It often arises from the posterior deep temporal, or from the middle meningeal.

κ. *R. buccalis* is a small irregular branch, frequently arising from the deep temporal, the meningeal, or the inferior dental. It proceeds from the lower part of the internal maxillary, and advancing forwards and downwards, sends numerous ramusculi into the buccinator muscle, the zygomaticus minor and major, the mucous membrane of the mouth, and to the other adjacent structures of the face,—especially to those situated near the angle of the mouth. It anastomoses freely with the transverse facial, the infra-orbital, and the facial arteries.

λ. *R. temporalis profundus anterior.* This branch arises higher up than the preceding. It advances directly upwards in the anterior part of the zygomatic fossa, between the temporal muscle and the surface of the cranium. It sends numerous ramusculi into that muscle, which anastomose with the posterior deep, and the middle temporal artery. It also gives off a small branch which traverses a foramen of the malar bone, to reach the lachrymal gland, and others of the same character to the fatty substance within the orbit.

μ. *R. dentalis s. alveolaris superior.* This is a considerable branch, which sometimes arises from the anterior temporal, or the infra-orbital. It takes its origin near the tuber of the superior maxillary bone, around the outer surface of which it twines in a tortuous direction. It first sends numerous small branches through the posterior foramina of the bone, to supply the large molars, and others which are expended upon the mucous membrane which lines the antrum;—then advancing forwards, along the surface of the alveolar process, and in the substance of the gums, as far as the canine tooth, it there sends small branches to the lesser molars, and terminates in several small branches which are distributed to the buccinator muscle, the fat of the cheek, and the gums and periosteum. One of these branches anastomoses with the infra-orbital.

Branches terminating the internal maxillary artery:

ν. *R. infra-orbitalis* takes its origin near the bottom of the orbit, and immediately assumes a horizontal direction forwards, to engage itself in the infra-orbital canal, the whole length of which it traverses, and finally escapes upon the face through the infra-orbital foramen, and beneath the levator labii superioris. Previously to entering the canal, it sends small branches to the fat and periosteum of the bottom of the orbit, and to the inferior rectus muscle. It also distributes branches to the inferior oblique muscle, the orbicularis palpebrarum, and to the lachrymal sac. While lodged in the canal, it sends small branches downwards into the antrum, to supply its mucous membrane; and near its orifice, one or more branches are sent to the canine and incisor teeth. Those which reach the face are distributed to the upper lip,

where they form a complex anastomosis with the superior dental, transverse facial, superior labial, and the nasal branches of the facial.

ξ. *R. vidianus* is a small reflected branch, which proceeds backwards through the vidian foramen, in company with the nerve of the same name, and is distributed to the upper part of the pharynx, the sphenoidal sinus, and the eustachian tube. It is frequently a branch of the superior palatine.

ο. *R. palatinus superior, s. descendens.* This branch comes off in the spheno-maxillary fossa near the bottom of the orbit, whence it descends in a perpendicular direction in the pterygo-maxillary fissure to engage itself in the posterior palatine foramen. Having traversed this opening, it sends small branches to the soft palate, and takes its course forwards along the lower surface of the bony vault of the palate and between it and the mucous membrane of the mouth, to which, as well as the gums, it sends small ramusculi. One of its terminal branches finally penetrates the anterior palatine foramen, through which it ascends into the nose, where it anastomoses with the nasal branches furnished by the facial.

π. *R. pharyngeus superior, s. descendens* is frequently a branch of the preceding, or of the spheno-palatine. It mounts upwards and forwards, and becomes engaged in the pterygo-palatine foramen, which it traverses, and is afterwards expended upon the upper part of the pharynx, the eustachian tube, and the body of the sphenoid bone.

ϱ. *R. spheno-palatinus, s. nasalis posterior.* This is the last branch of the internal maxillary artery, and may be reregarded as its proper termination. It ascends through the pterygo-palatine foramen to the posterior nares, and either before it has traversed that opening, or afterwards, divides into external and internal branches. The first enters the nose near the posterior part of the upper meatus, where it is covered by the mucous membrane. It sends ramusculi to the superior and inferior turbinated bones, to the mucous membrane lining the nose, to the posterior ethmoidal cells, to the sphenoidal sinus, and likewise to the antrum. One or more of these branches anastomose with the anterior palatine after it has traversed the foramen incisivum. The internal branch goes to the septum of the nose, and ramifies extensively upon the mucous membrane. It distributes, besides, several small ramusculi to the upper part of the pharynx, and some to the ethmoidal cells.

Varieties of the external carotid artery and its branches. Several varieties in the origin of the carotid arteries have been already mentioned. Those which remain to be noticed, have reference particularly to the point at which it divides in the neck. Generally, the common carotid divides into external and internal on a level with the upper margin of the thyroid cartilage. Burns, however, has described a case, in which the division took place much lower—on a level with the sixth cervical vertebra. The trunks, which were of nearly equal size, mounted up the side of the larynx parallel to each other, and were enveloped in the same sheath with the internal jugular vein and the pneumogastric nerve. (*Observat. on the diseases of the heart.* p. 285.) An instance has likewise been reported by Morgagni (*De sed. et caus. morb.* Lib. III. ep. xxix. 20.), in which the left common carotid divided six inches above its origin. Sometimes the common carotid gives off branches laterally as it advances upwards, and does not divide until it reaches the styloid process, where it terminates in two branches, one of which is the internal carotid,—the other the common origin of the temporal and internal maxillary. (Burns. *Loc. Cit.*) In another case described by Burns, the external carotid was a short thick stump, resembling the axis arteriæ cœliacæ, from the top of which the several branches took their origin. This interesting preparation is now before us, and belongs at present to the collection of the University of Maryland. A similar example has been figured by Munz. (*Handbuch der Anatomie, mit Abbildungen.* T. vi. fig. 4.)

The *superior thyroid artery* is subject to several varieties in its origin and distribution. Sometimes it arises from the common carotid below the point at which that vessel divides. (Burns.) It is, in a few instances, wanting on one side, or remarkably small; the defect in such cases being compensated by the greater development of the inferior thyroid. Occasionally it arises from the external carotid, by a common trunk with the lingual. Sometimes there is a second superior thyroid, which arises from the external carotid above the first; and in such cases, the upper one occasionally furnishes the laryngeal branch and the lingual artery. (Tiedemann. Tab. VII. fig. 1.) The laryngeal branch is not unfrequently a branch of the external carotid; and some-

times it arises from the lingual. (Munz. Tab. VIII.)

The *lingual artery*, besides arising in some cases in common with the superior thyroid, may come off by a common trunk with the facial. (Burns.) This latter artery sometimes furnishes the sublingual branch, and in a case in which there was a second superior thyroid, Tiedemann observed the dorsalis linguæ arising from the lower one, while the other vessels of the tongue proceeded from that which came off above.

The *facial*, or *external maxillary artery*, arises, in some instances, in common with the lingual. Sometimes it furnishes the *a. ranina.* (Meckel.) Occasionally it is preternaturally small, and does not extend beyond the corner of the mouth; and in two or three cases observed by Burns, it was not larger than a sewing-thread where it passed over the lower jaw. Under such circumstances, the transverse facial artery supplies the lips and nose. In another instance observed by the same author, the facial artery took its origin from the temporal, near the angle of the jaw; and there was, besides, given off from the portion of the external carotid which usually furnishes the facial artery, a branch which supplied the submental, and then ascended behind the ascending plate of the lower jaw, supplying the place of the internal maxillary artery. (*Op. Cit.* p. 289.)

The *pharyngeal artery* sometimes arises in common with the facial (Sabatier, &c.); sometimes from the occipital. (Haller, Green.) It has been seen arising, in several instances, from the bifurcation of the carotid, as the sacra media does from the bifurcation of the aorta. (Green. *Varieties of the arterial system.* p. 9. Dublin, 1830.) In some instances it comes from the superior thyroid. (Mayer.) Sometimes there are two pharyngeal arteries.—one from the external, and one from the internal carotid. (Haller, Sœmmering.) The same authors report, that they have seen three. In such cases, one branch usually proceeds from the facial. (Tiedemann.)

The *occipital artery* was observed once by Haller, and twice by Tiedemann, arising from the internal carotid. A case was reported to Green, in which it arose from the vertebral.

The *posterior auricular artery* sometimes comes off higher up than usual, near the division of the external carotid into the temporal and internal maxillary. (Barclay.) In some instances, it is a branch of the occipital. (Haller.)

The *stylo-mastoid*, which is generally a branch of the posterior auricular, not unfrequently arises from the occipital; and in one instance, Haller saw it coming off from the external carotid.

The varieties of the temporal and internal maxillary arteries are too unimportant to deserve much attention. When the facial is small, the transverse artery of the face is generally large, and supplies the superior labial branch, as well as those which are proper to the nose. In one case, Sabatier saw the middle meningeal artery entering the cranium through the squamous suture. In some instances, this artery furnishes the lachrymal, which is usually a branch of the ophthalmic. In such examples, it enters the orbit through the greater wing of the sphenoid. (Sœmmering.)

F. The *internal carotid artery.* (*Fig.* 2. *l.*) (*R. carotis internus, s. cerebralis.*) The point at which this vessel separates from the external carotid artery on a level with the cartilages of the larynx, has been already described. It is generally somewhat smaller than that vessel, and at its origin forms a slight curve outwards, which renders it more superficial there than at any other point. It then ascends in front of the cervical vertebra, and behind the digastric and styloid muscles and parotid gland, to the base of the cranium, where it enters the carotid canal of the petrous portion of the temporal bone, which it traverses to reach the cavity of the cranium. It is finally distributed to the anterior part of the brain, and the eye.

In studying the relations and distribution of the internal carotid artery, it should be divided into three portions:

The first, or cervical portion, comprises the part between the origin of the artery and its entrance into the carotid canal. It is slightly flexuous, and becomes more and more profound as it ascends. It reposes posteriorly upon the rectus capitis muscle, the pneumogastric and sympathetic nerves, and the superior cervical ganglion: anteriorly, it is accompanied by the external carotid artery and the jugular vein;—and it is, besides, crossed in front by the digastric and styloid muscles, and the lingual and glosso-pharyngeal nerves. Finally, at its upper part, it is profoundly situated, and is covered by the parotid gland. The internal jugular vein, which is in front of the internal carotid, is also inclined slightly towards its external

side; while along its internal surface, it is in contact below with the pharynx, and above, is but slightly removed from the tonsils, with which it is connected by loose cellular tissue. In this course, the artery does not usually furnish any branches; but occasionally it supplies one or more of those which are generally sent off by the external carotid, and, more frequently, a small branch to the palate and fauces.

The second part of the artery is lodged in the petrous portion of the temporal bone. It enters the carotid canal in a perpendicular direction, but immediately inclines obliquely forwards, almost in a horizontal direction, but still advancing slightly upwards and inwards, along the outer side of the tympanum and labyrinth, and parallel with the eustachian tube. Finally, it escapes from the carotid canal, where it takes a direction upwards, forwards, and inwards, reaches the side of the sella turcica, and perforates the deep layer of the dura mater which forms the cavernous sinus. The portion of the artery which is lodged in the carotid canal, is accompanied by several small ascending filaments of the sympathetic nerve, which form a plexus upon its surface. It sends a small branch to the tympanum, which is distributed to its lining membrane and the promontory, and anastomoses with the ramifications of the stylo-mastoid branch and the middle meningeal; and a second which traverses the vidian foramen.

Finally, the third, or cerebral portion of the internal carotid artery, runs in nearly a horizontal direction forwards, along the side of the body of the sphenoid bone, embedded in the cavernous sinus, but separated from its proper cavity by the lining membrane which is reflected upon the course of the vessel. In this part of its distribution, it is accompanied by the external motor nerve, and has the cavernous ganglion reposing upon its surface. Having reached the anterior clinoid process, it assumes a vertical direction and perforates the dura mater: then inclining slightly backwards, posteriorly and externally to the optic nerve, and carrying with it a reflection of the arachnoid membrane, it reaches the inner extremity of the fissure of Sylvius, and divides into the ophthalmic (*Fig.* 6. *a.*) and cerebral arteries.

Whilst engaged in the cavernous sinus, it distributes small ramuli to the lining membrane of the sphenoidal sinus, the dura mater, pituitary gland, and to the third, fourth, fifth, and sixth pairs of nerves. The numerous and sudden flexures presented by this vessel, during its transit through the bone, are particularly worthy of observation, as they show a provision of nature well calculated to prevent a too sudden ingress of blood upon the delicate compages of the brain.

Fig. 6.

a, Ophthalmic. *b*. Lachrymal. *c*. Posterior Ethmoidal. *f*. Inferior Palpebral. *g*. Anterior Ethmoidal. *h*, Nasal. *i*, Frontal. *k*. Superior Palpebral. *l*, Carotid. *m*, Optic Nerve.

a. *Ophthalmic artery.* (*Figs.* 6, 7. *a.*) (*R. ophthalmicus.*) The ophthalmic artery is a branch of considerable magnitude. It comes off from the curvature formed by the internal carotid, at the point at which it assumes a perpendicular direction, by the side of the anterior clinoid process, and enters the orbit through the foramen opticum, placed at first along the outer inferior part of the optic nerve, and between the external motor nerve and the corresponding rectus muscle of the eye. It then ascends slightly, crosses the upper surface of the nerve obliquely, and running between it and the upper rectus muscle, inclines towards the inner part of the orbit, and finally advances forwards, along the inner side of the nerve, to the internal canthus of the eye, where it terminates by dividing into other branches.

α. *R. lachrymalis.* (*Fig.* 6. *b.*) This is the largest of the branches furnished by the ophthalmic, from the outer part of which it takes its origin,—generally after that vessel has entered the orbit, but some-

times before. In the latter case, it passes through the foramen lacerum, or through a separate aperture either in the greater wing of the sphenoid, or the malar bone. It advances along the superior external part of the orbit, above the upper edge of the external rectus muscle, and beneath the superior rectus and levator palpebrarum, towards the lachrymal gland. Having reached that body, it glides along either its upper or lower surface, sends numerous small ramifications into its substance, and divides into two branches. The first, which is inferior, is distributed to the orbicularis palpebrarum, where it anastomoses along the margin of the inferior tarsus, to form an arch, with the inferior palpebral and the superficial temporal. The second advances upwards, and forms a similar anastomosis in the muscles and skin of the upper lid. Both these branches ramify extensively in the upper and lower eye-lids and the adjacent portion of the conjunctiva.

The lachrymal artery, in the course of its distribution, sends small branches to the dura mater, the cavernous sinus,—to the external and superior rectus muscles of the eye, the levator palpebrarum, the periosteum, and to the fibrous expansion of the eye-ball. It also gives off small branches near the anterior part of the orbit, which traverse the malar bone, and anastomose with the profound temporal. In some subjects, it furnishes one or more ciliary branches.

β. *R. centralis retinæ.* (*Fig.* 7. *b.*) The central artery of the retina generally arises from the ophthalmic, some distance behind the eye-ball,—sometimes from one of the ciliary arteries, or even the inferior muscular. It penetrates the outer part of the optic nerve obliquely, and traverses the centre of its axis to the bottom of the eye, which it enters by one or more branches. Having thus reached the point at which the expansion of the retina commences, it distributes a number of extremely delicate ramifications upon that structure, which form a fine vascular net-work upon the whole extent of its inner surface. Some of these ramifications reach the corpus ciliare, between which and the vitreous humour they form a vascular circle, and send minute ramusculi to the crystalline lens. A very delicate branch of the central artery advances directly through the centre of the vitreous humour, and distributes its minute ramusculi upon the posterior surface of the crystalline.

γ. *R. supra-orbitalis, s. muscularis superior* (*Fig.* 7. *c.*) arises from the ophthalmic while it is crossing the upper surface of the optic nerve. Sometimes it arises from the lachrymal, or one of the ciliary branches. It advances upwards beneath the vault of the orbit, and between it and the levator palpebrarum and the superior rectus muscle; to which it furnishes branches. Having reached the upper margin of the orbit, it glides through the superciliary notch, and divides into an internal and external branch. The first ascends upon the forehead, supplying the corrugator supercilii, the orbicularis palpebrarum, and occipito-frontalis, and forms a free anastomosis with the frontal and superficial temporal arteries: the second also ascends to supply the structures situated over the external part of the eye, and anastomose with the terminal ramifications of the lachrymal.

Fig. 7.

a, Ophthalmic. *b*, Centralis Retinæ. *c*, Supra-orbital. *d*, Ciliares Breves. *e*, Posterior Ethmoidal. *g*, Anterior Ethmoidal. *l*, Carotid. *m*, Optic Nerve.

δ. *R. ciliares breves.* (*Fig.* 7. *d.*) The short ciliary arteries are exceedingly small, and vary both as regards number and origin. They generally take their origin from the ophthalmic in the vicinity of the optic nerve, but frequently a part of them arise from some of its branches. They plunge immediately into the bed of adipose substance which surrounds the optic nerve, and penetrate the sclerotic coat of the eye, near its junction with the optic nerve, in form of minute ramusculi, varying in number, from twenty to forty. They advance upon the outer surface of

the choroid, where, by dividing at very acute angles, and forming frequent anastomoses with each other, they develope a beautiful vascular plexus, occupying the whole extent of that membrane, and constituting an important part of it. They are finally distributed to the ciliary bodies and processes, and to the greater circumference of the iris, in all of which they form a series of delicate vascular arches by their numerous anastomoses. A few of them, of small size, do not reach the choroid, but are expended upon the fat at the bottom of the eye, the tunics of the optic nerve, and the sclerotica.

ε. *R. ciliares longiores* are usually two in number, one internal, the other external, which proceed directly forwards along the corresponding surfaces of the eye-ball, and perforate the sclerotic coat in advance of the preceding. They then advance in direct lines, along the outer surface of the choroid, furnishing it with but few branches, and perforate the ciliary ligament, after which, each one divides into two branches. They anastomose with several small branches denominated anterior ciliary, which perforate the sclerotic immediately behind its junction with the cornea, and then reunite with each other, to form a vascular circle in the greater circumference of the iris. From the convexity of this arch, a number of vessels proceed to form a similar one of smaller size, and it in its turn sends off an infinity of delicate branches, which advance in a serpentine direction towards the margin of the pupil, where, by inosculating with each other, they constitute a vascular zone or circle, surrounding the entire contour of that aperture.

ζ. *R. ciliares antici.* The preceding branch, and sometimes the inferior muscular, send off several small ramusculi, denominated anterior ciliary arteries, which perforate the sclerotica in the vicinity of its attachment with the cornea, and anastomose with the long ciliary branches, to form the vascular zone of the iris. Some of their ramifications are likewise distributed to the choroid and corpus ciliare.

η. *R. muscularis inferior.* This muscular branch generally arises from the ophthalmic in the vicinity of the optic nerve, and not far from the origin of the lachrymal and ciliary branches. It proceeds forwards and inwards, between the nerve and the inferior rectus muscle, and distributes branches to both these parts, to the external rectus, the inferior oblique, the fat and periosteum of the orbit, and finally to the lachrymal sac and lower eye-lid, where it anastomoses with the infra-orbital branch.

ϑ. *R. æthmoidalis posterior* (*Figs.* 6, 7. *e.*) does not exist constantly, and in some instances it arises from the lachrymal or supra-orbital branches, instead of the ophthalmic. It takes its course towards the inner part of the orbit, between the internal rectus and supérior oblique muscles of the eye, and becomes engaged in the posterior ethmoid foramen, which it traverses. It distributes small branches to the lining membrane of the posterior ethmoid cells, and then enters the cranium, where it sends small ramusculi to the dura mater in the vicinity of the cribriform plate of the ethmoid bone, and furnishes others, which pass with the filaments of the olfactory nerve into the nose. Several of its ramifications anastomose with the anterior ethmoid branch.

ι. *R. æthmoidalis anterior.* (*Figs.* 6, 7. *g.*) This branch arises farther forwards than the preceding, advances directly inwards, above the superior oblique muscle, and enters the nose through the anterior ethmoid foramen, in company with the nasal nerve. It distributes branches to the frontal sinuses, and to the membrane which lines the anterior ethmoid cells. It then enters the cranium like the preceding, supplies the adjacent portion of the dura mater, and terminates by numerous small ramusculi, which pass downwards through the cribriform plate of the ethmoid bone, to be expended upon the lining membrane of the nose.

κ. *R. palpebralis inferior* (*Fig.* 6. *f.*) usually arises from the ophthalmic a little beyond the trochlea of the oblique muscle, but is sometimes given off by the nasal; and occasionally it and the inferior palpebral branch arise by a common trunk. It sends small ramusculi to the lachrymal sac, the carnucula lachrymalis, and the adjacent portion of the conjunctiva. Then descending behind the palpebral ligament, it divides into two branches, one of which is distributed to the lower half of the orbicularis palpebrarum, while the other advances along the inferior tarsal cartilage, and supplies it, as well as the meibomian glands, conjunctiva, and skin, with small vessels. It anastomoses with the infra-orbital branch, and with the ramifications of the transverse facial.

λ. *R. palpebralis superior.* (*Fig.* 6. *k.*) This small branch arises near the preceding. It sends small branches to the lachrymal sac and caruncle, and the conjunctiva; then perforates the orbicularis

palpebrarum of the upper eye-lid, and passes outwards along the margin of the superior tarsal cartilage, sending branches to it and the adjacent structures, and terminating by anastomosing with the lachrymal branch.

Having furnished all these branches, the ophthalmic artery terminates by dividing into two branches,—the *frontal* and the *nasal.*

μ. *R. nasalis.* (*Fig.* 6. *h.*) The nasal artery is exceedingly variable in size, being sometimes large, but frequently very small. It escapes from the orbit above the palpebral ligament, whence it descends upon the nose, supplying the lachrymal sac, the orbicularis palpebrarum, and the adjacent structures of the nose,—and terminates by forming a delicate vascular plexus upon the latter, by its free anastomosis with the facial. Some of its ramusculi pass through the bones and cartilages of the nose, to supply the Schneiderian membrane.

ν. *R. frontalis* (*Fig.* 6. *i.*) is generally somewhat smaller than the preceding. It escapes from the upper internal part of the orbit, between the orbicularis palpebrarum and the bone. It immediately divides into three or more branches, which ramify extensively upon the forehead, and after having supplied the orbicularis palpebrarum, corrugator supercilii, and frontal muscles, and the adjacent integuments, anastomoses with the frontal of the opposite side, and the anterior branches of the superficial temporal.

The internal carotid artery having given off the ophthalmic, proceeds upwards and backwards, and sends off several branches, which are expended upon the anterior part of the brain,—the posterior arteries of the organ being supplied by the vertebral. It sends some unimportant branches to the posterior part of the optic nerve, the adjacent portions of the membranes of the brain, and the infundibulum. Then ascending, it divides into a series of anterior and posterior branches,—the first of which is,

b. The communicating artery of Willis. (*R. communicans Willisii, s. posterior.*) (*Fig.* 9. *a.*) This branch varies much in size, but is seldom absent. It advances upwards and slightly inwards, between the middle lobe of the brain and the tuber cinereum, and by the side of the mamillary eminences, where it meets and unites with the posterior cerebral branch of the basilar, thus forming the posterior part of the circle of Willis. It distributes small branches to the floor of the lateral ventricles, the commissure of the optic nerves, the optic conches, tuber cinereum, mamillary bodies, cruræ of the brain, and the plexus choroides.

c. Artery of the choroid plexus. (*R. choroideus.*) This is usually a very small branch, and not unfrequently it arises from the communicans of Willis. It proceeds outwards and backwards, over the surface of the peduncle of the cerebrum, and after giving small branches to the pia mater, plunges into the lateral ventricle, and distributes its ramifications to the plexus choroides and the thalamus nervi optici.

f. The anterior cerebral artery (*r. cerebri anterior*) (*Fig.* 9. *b.*) proceeds forwards and inwards, towards the longitudinal fissure which separates the anterior lobes of the brain from each other, gradually approaching its fellow of the opposite side, with which it is connected by a stout transverse branch (*ramus communicans anterior*). In this course, it gives small branches to the optic and olfactory nerves, the anterior commissure, and the adjacent portion of the fornix and septum lucidum. It then engages itself in the longitudinal fissure, between the corresponding lobes of the brain, ascends until it reaches the level of the border of the corpus callosum, over which it is reflected backwards and upwards, and finally continues its course along the entire extent of the upper surface of that body, by the side of the rapha, and terminates at its posterior margin, by anastomosing with the branches of the basilar artery. This portion of the vessel has been denominated *arteria corporis callosi.* While traversing the upper surface of that body, it distributes numerous minute ramusculi downwards into its substance, and laterally into the internal portion of the hemispheres of the brain.

g. The middle cerebral artery (*Fig.* 9. *c.*) (*ramulus cerebri medius*) is much larger than the preceding, and may be considered the terminating branch of the internal carotid. It runs directly outwards and backwards towards the fissure of Sylvius, and distributes minute branches to the pia mater, where that membrane is reflected over the peduncle of the brain, to the substance of the brain itself, and one branch which plunges into the inferior horn of the lateral ventricle, to supply the plexus choroides. The artery then enters the fissure of Sylvius, between the anterior and middle lobes, and after proceeding a small distance, divides into two branches of nearly equal size, which, pursuing the course of the fissure upwards, outwards, and backwards, towards the superior

lateral, and posterior portion of the brain, send off an infinity of ramifications to the anterior and middle lobes. These plunge into the numerous infractuosities of the organ, and after ramifying and anastomosing extensively with each other, to form a delicate and complicated vascular plexus upon the pia mater, they distribute a number of minute ramusculi into the substance of the organ.

Before the arteries of the posterior part of the brain can be studied, it will be necessary to trace the distribution of the subclavian, from which the vertebral,—the artery that furnishes these vessels, takes its origin.

G. The *Subclavian Arteries* (*arteria subclavia, dextra et sinistra*) (*Fig.* 1. *h, f. Fig.* 2. *m.*) occupy the upper part of the thorax, and the lower lateral part of the neck, and extend from the innominata on the right side, and the arch of the aorta on the left, over the upper surface of the first rib, in the interval between the anterior and middle scalenus muscles. The right subclavian is a little larger than the left, and as it arises from the innominata, while the left proceeds directly from the arch of the aorta, it is shorter, more superficial, and less perpendicular in its direction. Hence, while both arteries are alike in their general arrangement, each one presents some peculiarities which it will be important to note. But to render these differences more easily intelligible, it will be useful to divide the trunk of the artery into three portions, according to the region it occupies, as follows:—1. the tracheal portion, extending from the origin of the vessel to the scalenus muscles: 2. the inter-scalenar portion, comprising that part included in the small triangular space formed by the anterior and middle scalenus; and thirdly and lastly, the omo-clavicular portion, extending from the outer limit of the scalenus muscles, to the lower margin of the second rib, where the artery descends behind the clavicle into the axilla, and takes the name of axillary artery. If these different portions be examined separately, it will be found that the two last are exactly alike on both sides, but that the first presents considerable differences in its situation, course, and relations, according as it is examined on the right or the left.

The right subclavian arises from the innominata, where it reposes upon the side of the trachea, and directly behind the right sterno-clavicular articulation. It ascends with an easy sweep outwards, to the upper surface of the first rib, where it glides over that bone, and between the anterior and middle scalenus muscles. In this course, it forms a curvature, the convexity of which is directed upwards and a little inwards,—the concavity downwards and outwards, looking towards the tip of the right lung, from which it is but slightly removed. In its transit from the trachea to the first rib, the right subclavian artery has in front, the skin and platysma myoides muscle, and the superficial fascia; the articulation of the sternum with the clavicle, the sterno-cleido-mastoid, sterno-hyoid and sterno-thyroid muscles, the strong expansion formed by the profound layer of the cervical fascia, a plexus formed by the thyroid veins, the pneumogastric nerve, which descends perpendicularly in front of it, in a small triangular space between the carotid artery and the internal jugular vein,—and finally, numerous superficial filaments of the sympathetic nerve. Near the inner limit of the scalenus muscle, the great internal jugular vein also descends in front of it, and the subclavian vein is situated in front, but a little lower down. Posteriorly, the tracheal portion of the right subclavian artery is in relation with the sympathetic nerve and its inferior cervical ganglion, the recurrent branch of the pneumogastric, which in coming off from the trunk of the nerve is reflected upwards and backwards to ascend upon the posterior part of the artery, and thus include it in a kind of loop;—the longus colli muscle, and the transverse process of the first dorsal vertebra. Superiorly and internally, the convexity of its arch forms an acute angle with the carotid artery; and inferiorly and externally, the concavity of the same curve is directed towards the pleura and the summit of the right lung, with which it comes in contact during inspiration.

The corresponding section of the left subclavian artery, arising as it does from the termination of the arch of the aorta, is much deeper seated, and is considerably longer. It also ascends in nearly a perpendicular direction, until it reaches the upper surface of the first rib, where it makes a sudden turn outwards to sweep over that bone, between the scalenus muscles. In front of it are the sternum, clavicle, and first rib, the inferior attachments of the sterno-mastoid, sterno-hyoid, and sterno-thyroid muscles. The great vena innominata, or left brachio-cephalic vein, crosses in front of it in a transverse direction,—while the pneumogastric and phrenic nerves descend perpendicularly

upon its anterior face, inclined a little to the right side. Nearly parallel with this portion of the subclavian artery, a little in front and on the right side, the left carotid artery, having the cardiac nerve in its vicinity, ascends to emerge from the thorax; and on the same aspect of the vessel, but a little backwards, is the œsophagus. On the left side, it is in relation with the left lung and pleura, which are placed slightly in advance; and posteriorly, it reposes upon the longus colli muscle, and the sympathetic nerve. The thoracic duct and the recurrent nerve also ascend upon its posterior aspect; but the former, after it has reached the first dorsal vertebra, sweeps forwards and a little outwards, over the upper part of the artery, to get in front, where it unites with the left subclavian vein, at its junction with the left jugular.

Thus far the subclavian artery of the right and that of the left side differ in important particulars in their distribution and relations,—differences which it is essential to bear in mind in attempting to secure them in a ligature. It will be seen, however, that both of them are so deeply seated, and so intimately connected and associated with important parts, as to render such an operation exceedingly hazardous; and accordingly the attempts which have been thus far made to secure the subclavian on the inner side of the scalenus muscle, have been productive of fatal consequences.

The two outer sections of the artery are so nearly alike on both sides, that the description of the right will apply equally well to the left.

The second section of the artery is of limited extent, merely comprising that portion of it which is included between the scalenus muscles. In its transit through this space, it reposes upon the surface of the first rib, over which it glides. It is, besides, in relation below with the upper portion of the right pleura, which is forced upwards towards the artery during inspiration. Posteriorly, it rests against the middle scalenus muscle near its attachment, and in front of it is the clavicular attachment of the sterno-mastoid muscle, and the insertion of the anterior scalenus, which has the phrenic nerve descending perpendicularly in front of it, and the subclavian vein crossing it, upon the same aspect, in a transverse direction, a little below the level of the artery. In this region, the first rib furnishes a solid point of support, against which the artery can be easily compressed during operations upon the upper extremities.

The third portion of the artery extends from the outer margin of the scalenus muscles to a level of the inferior margin of the second rib, where the vessel descends behind the clavicle, and takes the name of axillary artery. It is here that its relations deserve most to be carefully studied, because in this portion of its transit, it can be most easily exposed and included in a ligature. In its course, it forms a slight curve, the convexity of which is upwards and outwards,—the concavity downwards towards the surface of the first and second ribs. It traverses the inferior part of the small triangle formed by the omo-hyoid muscle and the clavicle, and is almost in contact, above and a little backwards, with the inferior chord of the axillary plexus of nerves; and inferiorly, with the subclavian vein, which, though somewhat lower down, when it becomes distended, sometimes ascends slightly in front of the artery. As the subclavian artery approaches the axilla, the inferior branch of the axillary plexus of nerves gets in front of it, so that the vein being below, the artery is situated between it and the nerve, but is a little further backwards at that point than either. In its whole course, the external third of the artery is covered in front by the platysma myoides and cervical fascia, a quantity of loose cellular tissue and lymphatic glands, and an intricate plexus of small veins. The supra-scapular artery, which generally advances outwards immediately above the clavicle, is sometimes situated in front of the subclavian; but the transverse cervical is usually so far above it, as to be out of the way of any operation performed upon it.

The subclavian artery does not usually give off any branches until it arrives near the scalenus muscle, where it furnishes a cluster of them, usually seven in number, which are divided into superior, inferior, and external. Of these, a part take their origin on the inner side of the scalenus muscle,—the others, from that portion of the vessel which is situated between the anterior and posterior scalenus, and above the first rib.

Superior branches. a. *R. vertebralis.* (*Fig.* 8. *a*, *a*, *a*.) The vertebral artery is the largest of the branches given off by the subclavian. It arises from the upper posterior part of that artery; advances upwards and a little outwards and backwards, between the anterior scalenus and

the longus colli muscles, and in front of the transverse process of the seventh cervical vertebra. It then engages itself in the foramen of the transverse process of the sixth cervical vertebra (*Fig.* 8. *a.*),—

Fig. 8.

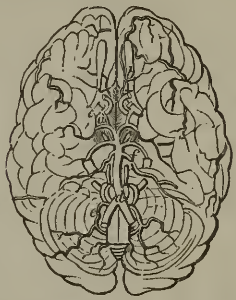
a, a, Vertebral. b, Posterior Cervical. c, Subclavian.

rarely in that of the seventh, the fourth, or the third, whence it ascends in a perpendicular direction, through the canal formed by the foramina of the transverse processes of all the vertebra above the sixth. Having traversed the process of the dentatus, it suddenly becomes tortuous, and inclines outwards, in consequence of the greater breadth of the atlas, to reach the foramen of that bone. In order to traverse this aperture, it again assumes the perpendicular direction, and then takes its course horizontally backwards and inwards, twining round the outer surface of the articulating process of the bone, and running along a groove which exists upon its upper surface. It finally penetrates the posterior occipito-atloid ligament and the dura mater, and enters the cavity of the cranium through the foramen magnum. From this point, the artery advances upwards and forwards, by the side of the spinal marrow, gradually converging towards its fellow of the opposite side, with which it unites at an acute angle, near the lower margin of the pons varolii, to form the *basilar artery.* (*Fig.* 9. *d.*)

While the artery is engaged in the canal formed by the transverse processes of the vertebra, it distributes numerous small ramusculi to the adjacent muscles of the spine, and some which pass inwards, through the inter-vertebral foramina to the spinal marrow. Between the dentatus and atlas, it gives off several small branches to the deep-seated muscles, and one of larger size, which advances backwards and inwards, beneath the inferior oblique muscle, and divides into two ramusculi. One of these is distributed to the muscles, —the other glides beneath the posterior arch of the atlas, and is expended upon the dura mater. Several small branches also arise from the vertebral in the space between the atlas and the occipital bone. They are distributed to the recti and oblique muscles, and to the adjacent portion of the complexus. A considerable branch advances inwards, in nearly a horizontal direction, between this latter muscle and the rectus capitis posticus major, to anastomose with its fellow of the opposite side, and form a kind of arch.

The most important branches of the vertebral artery are those which it gives off within the cranium. They are usually three in number;—the *posterior* and *anterior spinal*, and the *inferior artery of the cerebellum.*

Fig. 9.



a, Posterior Cerebral. b, Anterior Cerebral. c, Internal Carotid. d, Basilar Artery. e, Inferior Cerebellic Artery. f, Superior Cerebellic Artery.

a. *Ramulus spinalis posterior* is a small branch, which generally proceeds from the outer part of the vertebral, near the corpora pyramidalia. It ranges downwards and backwards, reaches the posterior part of the spinal marrow, and descends parallel with its fellow, near the posterior groove of the chord, as low as its termination on a level with the second lumbar vertebra. It sends numerous small branches to the membranes of the spinal chord, and minute capillary branches to its substance. It forms, besides, numerous anastomoses with its fellow of the opposite side, as well as with the branches of the vertebral, the profound cervical, and the intercostals.

6. *Ramulus spinalis anterior.* This branch is generally somewhat larger than the preceding. It arises from the inner part of the vertebral near its termination, —sometimes from the inferior cerebellic, or even the basilar. It descends in a tor-

tuous direction in front of the spinal marrow, as low as the foramen magnum, where it unites at an acute angle with its fellow of the opposite side, to form a common trunk. This latter descends in front of the spinal chord, along the median line, to the articulation of the sacrum with the coccyx, where it terminates by anastomosing freely with the lateral sacral arteries. In its whole transit, the anterior spinal artery distributes its ramifications to the spinal marrow and its membranes. It also sends off numerous internal and external branches, which anastomose in the same manner as the ramifications of the posterior spinal.

γ. *Ramulus cerebelli inferior* (*Fig.* 9. *e.*) is usually the last branch given off by the vertebral before its termination, and sometimes arises from the basilar. It proceeds outwards across the pyramidal body of the medulla oblongata, and in the space between the radicles of the pneumogastric and the spinal accessory nerves. In most cases, it divides, near its origin, into two branches,—one internal and the other external, which sometimes indeed have an independent origin. The first winds round towards the posterior part of the medulla oblongata, sends numerous small branches to the plexus choroides of the fourth ventricle, and terminates about the vermiform process. The second sends small ramifications to the radicles of the eighth and ninth pair of nerves, pursues a tortuous direction outwards and downwards upon the lower surface of the cerebellum (*Fig.* 9.), and is extensively distributed upon the pia mater and in the infractuosities of the organ. It anastomoses freely with the superior cerebellic artery.

δ. *Ramulus basilaris.* (*Fig.* 9. *d.*) This artery, it has been already mentioned, is formed by the union of the two vertebrals. It commences at the posterior margin of the pons varolii, where this joins the medulla oblongata. It proceeds directly forwards, between the sixth pair of nerves, and along the groove which occupies the lower surface of the pons varolii. Having reached the anterior border of this latter body, it divides in the vicinity of the crura cerebri into two branches, which separate from each other at an obtuse angle.

The basilar artery sends many small ramifications to the pons varolii and medulla oblongata; the origin of the adjacent nerves, and to the pia mater. It also gives origin to the superior cerebellic artery, which goes to the upper part of the cerebellum.

ε. *Ramulus cerebelli superior, s. anterior.* (*Fig.* 9. *f.*) The superior cerebellic artery arises from the basilar near its termination, whence it winds round beneath the peduncle of the cerebrum and the pons varolii, to ascend upon the upper surface of the cerebellum near the tubercula quadragemini. It sends branches to the peduncles, pons varolii, tubercula quadragemini, pineal gland, and valve of Vieussens, and then running in a tortuous direction outwards and backwards, divides into two orders of ramifications. The first follow the upper surface of the cerebellum to its posterior margin, supplying the pia mater and the plates of the organ, and terminating by forming a free anastomosis with the inferior cerebellar artery. The others are in part distributed to the anterior part of the cerebellum, while some of them ascend upon the posterior lobes of the cerebrum. A branch of this artery, —sometimes of the basilar itself, is distributed to the labyrinth of the ear, which it reaches through the internal auditory foramen, in company with the auditory nerve.

ζ. *Ramulus cerebri posterior.* (*Fig.* 9. *a.*) The basilar artery having reached the space between the pons varolii and the mammillary bodies, terminates by dividing into two symmetrical branches, which are distributed to the posterior lobe of the cerebrum. The posterior cerebral artery, thus taking its origin, winds at first forwards and outwards beneath the peduncle of the brain, and then backwards, having the common motor nerve between it and the vessel last decribed. It finally reaches the inferior surface of the posterior lobe of the cerebrum, ramifies minutely upon the pia mater, and in the infractuosities of the organ, and distributes minute capillary branches to its substance. Near its origin, it sends branches to the crura of the brain, the mammillary bodies, tuber cinereum, and the pons varolii. It also sends a branch into the third ventricle, to supply the thalamus, striated body, the anterior pillars of the fornix, and the plexus choroides. Near the motor nerve, its anterior convex surface receives the communicating branch from the internal carotid, which thus completes the circle of Willis. Beyond this point, it sends other branches to the pons varolii, the cornu ammonis, tubercula quadragemini, pineal gland, and thalamus.

The union which is formed between the posterior cerebral arteries and the internal carotids, completes a circle of an irregular shape, which occupies the base of the brain, and circumscribes the mam-

millary bodies, the tuber cinereum, and commissure of the optic nerves.

b. *Ramus thyroideus inferior.* (*Fig.* 2. *n.*) The inferior thyroid artery varies much in size, according to the number of branches to which it gives origin. In the fœtus, when the thyroid gland is very large, it almost equals the subclavian itself: and in the adult, when besides the thyroid proper, and the ascending cervical, it supplies the supra-scapular and transverse cervical, it is very large, and represents a short thick stump, from which a switch of branches proceeds. It arises from the upper part of the subclavian, immediately on the outer side of the vertebral, but a little more forwards. The trunk of the inferior thyroid is placed perpendicularly upon the internal margin of the anterior scalenus muscle, but does not ascend far before it divides into two branches,—the inferior thyroid proper, and the ascending cervical.

α. *Ramulus thyroideus inferior proprius.* (*Fig.* 2. *n.*) This branch, proceeding from the common trunk, inclines upwards and inwards, behind the carotid artery and pneumogastric nerve, and in front of the vertebral artery and the longus colli muscle. In its course, it gives branches to this muscle, and others to the trachea and œsophagus, which descend into the thorax, and anastomose with the bronchial artery. The inferior thyroid finally reaches the external border of the thyroid gland, ramifies very extensively through the whole of its inferior part, and forms a most complex anastomosis with the thyroid branch of the external carotid.

β. *Ramulus cervicalis ascendens.* (*Fig.* 2. *o.*) The ascending cervical ramulus takes its origin from the posterior part of the inferior thyroid, where it changes its direction—sometimes from the subclavian itself, or the internal mammary. It ascends in front of the transverse processes of the cervical vertebra, between the rectus capitis anticus, and the scaleni muscles, gradually inclining backwards as it advances, and terminates about the level of the first or second cervical vertebra, by dividing into two branches. One of these passes towards the posterior part of the transverse processes, and supplies the trachelo-mastoideus and the oblique and recti muscles upon the back of the neck, where it anastomoses with the occipital, vertebral, and posterior or profound cervical arteries. Some of its terminal ramifications penetrate between the first and second cervical vertebra, and are expended upon the membranes of the spinal marrow. The other branch inclines outwards, and is distributed to the complexus, and the posterior part of the digastric muscle.

In its course, the ascending cervical ramulus gives branches outwards to the scaleni, levator scapulæ, and trapezius muscles; forwards to the mastoid; and inwards to the glands of the neck, the eighth pair of nerves, the cervical ganglion of the sympathetic, and several which pass with the cervical nerves through the intervertebral foramina, to be distributed upon the membranes of the spinal marrow, where they anastomose freely with the spinal ramusculi of the vertebral artery.

γ. *Ramulus cervicalis superficialis.* (*Fig.* 2. *p.*) The superficial cervical ramulus, which is very constant in its existence, has been very carelessly described by anatomists, some of them representing it as a distinct branch, others confounding it with the transverse cervical, while many have omitted it altogether. It generally arises from the inferior thyroid artery, but sometimes from the ascending cervical, and occasionally from the subclavian. It proceeds outwards, backwards, and a little upwards, in front of the anterior scalenus muscle, beneath the omohyoideus, and in front of the brachial plexus of nerves. It finally glides beneath the trapezius, sends ramusculi to that muscle and the levator scapulæ, and terminates by numerous small branches which are distributed to the supra-spinatus muscle, and the rhomboideus major and minor. Some of the latter descend for some distance along the base of the scapula. The superficial cervical artery gives off, in its course, small branches to the mastoid and scaleni muscles; one or more to the brachial plexus of nerves; and several, of small size, to the glands and other structures which occupy the supraclavicular region.

External branches. a. *Ramus scapularis superficialis, s. transversus scapulæ, s. scapularis superior.* (*Fig.* 2. *q.*) This is a considerable branch, which arises perhaps more frequently from the inferior thyroid than from the subclavian itself. It also takes its origin, in some instances, in common with the transverse cervical, or even from the internal mammary. In either case, it commences upon the inner side of the scalenus muscles, and is covered by the sterno-cleido-mastoideus. In this situation, it sends small branches to these muscles, and to the sterno-hyoideus and sterno-thyroideus. It then proceeds directly outwards, either in front or be-

hind the scalenus anticus, and a little above and posterior to the clavicle, parallel with which it runs throughout its whole course. Having reached the margin of the trapezius muscle, it glides beneath it, until it arrives in the vicinity of the coracoid process, where it reposes close upon the scapula, and is merely separated from the supra-scapular nerve by the coracoid ligament, which, with the notch of the scapula, completes the foramen through which the nerve passes, while the artery glides over the surface of the ligament. The artery here gives off several branches, which ramify upon the capsular ligament of the shoulder-joint, and in the upper anterior portion of the deltoid muscle, forming a free anastomosis with the anterior circumflex. It also sends a branch backwards, along the supra-spinal fossa, to supply the supra-spinatus muscle, and others to the trapezius. The continuous or terminal portion of the vessel (*Fig.* 10. *e.*), then glides along the neck of the scapula, beneath the arch formed by the spine, to reach the infra-spinal fossa, where it ramifies extensively in the infra-spinatus, teres minor and major, and anastomoses posteriorly with the posterior scapular branch of the transverse cervical, and anteriorly with the circumflex branch of the subscapular artery. In its course, the supra-scapular artery distributes minute branches to the glands of the neck, and the plexus of nerves.

b. *Ramus transversalis colli, s. scapularis posterior* (*Fig.* 2. *r. Fig.* 10. *b.*) is generally larger than the preceding. Its most common origin is from the subclavian, immediately on the inner side of the scalenus muscles, or where that artery reposes between them. Sometimes, however, it is a branch of the inferior thyroid, and in some instances it arises by a common trunk with the supra-scapular. It proceeds outwards and backwards, across the triangular space of the neck formed by the sterno-mastoid and trapezius muscles, and the clavicle. In its transit through this region, it glides over the brachial plexus of nerves, — sometimes through it, — passes beneath the trapezius and levator scapulæ, and having arrived at the angle of the scapula, descends in nearly a perpendicular direction upon the back, along the base of that bone, covered by the rhomboid muscles, and terminates by numerous ramifications, which are spent upon the neighbouring muscles, in the vicinity of the inferior scapular angle.

In its course, the transverse cervical artery first gives branches to the scaleni muscles, to the plexus of nerves, and the glands and integuments of the neck It sends several considerable branches to the trapezius and levator scapulæ muscles. Near the angle of the scapula, it gives off a large branch which immediately subdivides; one branch advancing forwards and outwards in the supra-spinal fossa, is distributed to the supra-spinatus and trapezius;—the other twines over the posterior surface of the angle of the scapula, and descends upon its dorsum, as low as the root of the spinous process. The continuous trunk of the artery, which is properly entitled to the appellation of posterior scapular (*Fig.* 10. *b.*), descends along the

Fig. 10.

b, Posterior Scapular. *c*, Circumflex of the Subscapular. *d*, Posterior Circumflex. *e*, Superior Scapular.

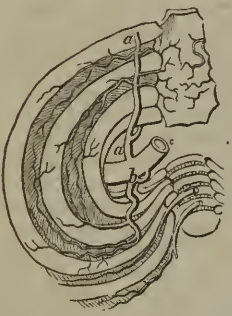
base of the scapula, covered by the rhomboid and trapezius muscles, to which it sends numerous branches, and in its course, distributes a great number of ramifications to the serratus major anticus, serratus superior posticus, and latissimus dorsi.

Posterior branches. c. *Ramus cervicalis posterior, s. profundus.* (*Fig.* 8. *b.*) This is a small deep-seated branch, not very regular in its origin. It most usually proceeds from the posterior part of the subclavian, where it reposes between the anterior and middle scaleni muscles; but sometimes from the inferior thyroid, the vertebral, or even the superior intercostal. It immediately twines outwards and backwards in the space between the transverse processes of the sixth and seventh cervical, or the seventh cervical and first dorsal vertebra, to reach their posterior

aspect. From this point it ascends in the space between the spinous and transverse processes, sending branches to the scaleni, rectus capitis, intertransversaria, transversalis cervicis, semispinalis cervicis, and complexus muscles; and others which traverse the intervertebral foramina, to be distributed to the membranes of the spinal marrow. It terminates by several small branches, which supply the deep-seated muscles about the upper part of the neck, and one of considerable size, which anastomoses with a branch of the occipital.

Inferior branches. a. *Ramus mammarius internus, s. sternalis.* (*Fig.* 11. *a, a.*)

Fig. 11.



a, a, Internal Mammary. *b*, Superior Intercostal. *c*, Subclavian.

The internal mammary artery comes off from the lower part of the subclavian, nearly opposite the origin of the inferior thyroid,—sometimes a little further inwards. It descends behind the cartilage of the first rib, and is crossed by the phrenic nerve in an oblique direction, as the latter passes from its outer to its inner side. From the first rib, it descends upon the posterior surface of the succeeding ribs and the intercostal muscles, as low as the space between the sixth and seventh, and glides between them and the triangularis sterni muscle. Above, it is about a finger's breadth from the margin of the sternum, but lower down it inclines towards the ensiform cartilage, and approaches its fellow of the opposite side. In the space between the sixth and seventh ribs, it divides into two branches, by which it terminates. The first, *r. musculo-phrenicus, s. diaphragmaticus*, inclines outwards, along the posterior surface of the cartilages of the false ribs, distributes numerous small branches to the diaphragm, passes between its digitations, and is finally distributed to the transverse and oblique muscles of the abdomen, where it anastomoses with the inferior intercostals, the superior lumbar, and the circumflexus ilii. The second, *r. abdominalis, s. epigastricus superior*, descends behind the rectus muscle, sending ramusculi into its substance, as low as the umbilicus, where it terminates by anastomosing with the epigastric artery. This branch, and sometimes the trunk itself, sends a small branch inwards, which ranges across the posterior face of the ensiform cartilage to anastomose with a similar one from its fellow. From this, a small ramusculus frequently descends in the suspensory ligament of the liver, to anastomose with the hepatic artery.

Besides these terminal branches, the internal mammary supplies many others in its course. Near its origin, it sends some to the sterno-hyoid and sterno-thyroid muscles, to the lymphatic glands about the root of the neck,—one or more to the bronchia, *r. bronchialis superior*, and to the remains of the thymus gland,—also to the anterior mediastinum. This latter branch, *r. mediastinus anterior*, is frequently of considerable size, and divides into two ramusculi, one of which ascends towards the neck, and sends some of its ramifications to the thymus and thyroid glands; while the other ascends in the anterior mediastinal space, and distributes its branches to the pericardium, the periosteum of the sternum, and the adjacent portion of the pleura. While it is still high up in the thorax, the internal mammary gives off a branch, *r. diaphragmaticus superior, s. comes nervi phrenici*, which descends in the course of the phrenic nerve, distributes numerous ramusculi to the pericardium and the parts contained within the anterior mediastinum, and is finally expended upon the anterior middle part of the diaphragm, where it anastomoses extensively with the inferior diaphragmatic or phrenic artery.

As the artery descends behind each intercostal space, it gives off a series of external and internal branches, generally corresponding in number to the number of spaces over which it glides. They are denominated anterior intercostals, *r. intercostales anterior*. Each of the *external branches* takes its course along the inferior margin of the corresponding rib, first beneath the pleura, then between the internal and external intercostal muscles, to which it sends numerous small branches. It finally anastomoses with the posterior intercostal artery of the same space sent off by the aorta, and sends several small branches forwards, which perforate the external intercostal muscle, and supply the pectoralis minor and major, and the mammary gland, and anastomose freely with the thoracic branches of the axillary.

The internal branches ramify extensively upon the periosteum of the posterior face of the sternum, and in the cellular tissue of the anterior mediastinum, where they form a free anastomosis with the vessels of the opposite side. Some of them perforate the intercostal muscles near the margin of the sternum, and are distributed to the muscles on the outer part of the thorax.

The external branches are larger as they are lower down, while the internal are larger above, and smaller below. Sometimes a small branch takes its course along the upper margin of each rib.

b. *Ramus intercostalis superior.* (*Fig.* 11. *b.*) This branch varies much in size, according as it supplies one or more intercostal spaces. It usually arises from the posterior part of the subclavian, a little exterior to the origin of the internal mammary, and immediately on the inner side of the scalenus muscle. Sometimes it comes off in common with the profound cervical, the internal mammary, or even the inferior thyroid. From its origin, it advances downwards and outwards, in front of the neck of the first rib, and if it supplies more than one intercostal space, in like manner in front of the second or even the third rib, as the case may be. Having reached the intercostal space, it divides into posterior and external branches. The first, *r. dorsales*, proceed backwards, and divide into two series of branches, one of which penetrates the intervertebral foramina to be distributed to the spinal marrow, where they anastomose with the spinal branches of the vertebral; the others advance directly backwards between the necks of the ribs, and are distributed to the deep-seated muscles of the back.

The external branch, *r. intercostalis*, advances outwards along the lower margin of the rib, between the internal and external intercostal muscles, and after proceeding a short distance, divides into a superior and an inferior branch. The first follows the inferior, the second the superior, margin of the ribs between which they are placed, supply the intercostal muscles, and form a free anastomosis with the posterior intercostals, and with the superior intercostal branch of the internal mammary. If more than one intercostal space is supplied by this artery, the second branch pursues precisely the same distribution.

Sometimes the superior intercostal furnishes branches to the œsophagus and bronchia; and very generally it distributes small ramifications to the posterior mediastinum and the bodies of the vertebra.

Varieties of the Branches of the Subclavian Artery:

Several of the most important anomalies of the origin of the subclavian artery have been described above. It only remains, therefore, to consider those which are most frequently observed in its several branches.

The *vertebral artery* very often departs from the origin and distribution detailed in its description. The most common of these varieties is the origin of the left vertebral from the arch of the aorta, between the left carotid and left subclavian. The right vertebral seldom arises from the arch of the aorta, and scarcely ever, except where the left presents a similar condition. Sometimes, however, it proceeds from the angle of the bifurcation of the innominata. (MECKEL.) Occasionally the left vertebral artery takes its origin from the aorta, beyond the point at which the left subclavian is given off. (MECKEL, *Handbuch der Path. Anat.* II. 109. WINSLOW.) Sometimes it arises from the aorta on the right side, in common with the inferior thyroid. (WALTHER, LODER.) Cases in which both vertebrals proceeded from the arch have been noted by PENADA, FIORATI, and MECKEL. In a few instances, the right subclavian and right carotid arise from the arch, having the right vertebral between them, while the left vertebral arises in a similar manner between the left carotid and the left subclavian. (TIEDEMANN, MULLER.) A much more rare anomaly is that in which the vertebral artery is double. Examples of this kind have been observed by HEBENSTREIT, HENKEL, HUBER, and MECKEL. In the cases described by HENKEL and HUBER, one branch proceeded from the arch—the other from the subclavian at the usual point. In both instances, the anomaly was on the left side. In HUBER's case, the normal branch was smaller than the other, with which it united, however, on a level with the fifth cervical vertebra, and entered the aperture in the transverse process of that bone. In the example of this anomaly reported by HENKEL, one of the two vertebrals which existed on the same side, entered the transverse process of the seventh—the other that of the eighth cervical vertebra. In one case observed by MECKEL, there were two vertebral arteries on the right-side, both of which proceeded from the subclavian. One of them penetrated the aperture in the transverse process of the sixth cervical vertebra, while the other entered that of the third. (*Handb. der Path. Anat.* II. 111.) OTTO reports a case in which the right vertebral

artery was preternaturally small, and engaged itself in the transverse process of the fourth cervical vertebra, the fifth, sixth, and seventh processes presenting no foramina. In another instance observed by the same gentleman, the upper part of the vertebral artery was transfixed by the hypoglossal nerve. (*Lehrbuch der Path. Anat.* I. 309.) A case still more singular has been described by Albert Meckel. There were three vertebral arteries on the right side, two of which proceeded directly from the subclavian, while the third had its origin from that vessel in common with the inferior thyroid. They all united into a common trunk about the middle of the neck, which entered the transverse process of the fourth cervical vertebra. (Meckel. *Archiv. für Anat. und Physiol.* 1828. p. 170.) When there are two vertebral branches on one side, the smaller, after ascending for some distance, plunges directly into the vertebral canal, through the intervertebral space. (Meckel.)

The vertebral artery when single, ordinarily enters the transverse process of the sixth cervical vertebra, but it may penetrate below or above this point. In some instances, but very rarely, it engages itself in the seventh. (Portal.) Oftener it penetrates the transverse processes higher up. It is frequently observed entering the fifth. Eustachius saw it penetrating the fourth; Haller the third; and Sœmmering remarks that it sometimes engages itself in this bony canal as high as the transverse process of the second cervical vertebra. In one instance, Burns saw it ascending to the level of the lower margin of the thyroid cartilage, before it entered the transverse processes. (Barclay.)

Meckel remarks, that in two instances he saw the basilar artery divided into two branches, which, after advancing a short distance, united with each other, thus circumscribing a small insular space. This anomaly he thinks must be rare, and it is worthy of observation, that in both the bodies in which it was observed, a similar scission of the anterior communicating branch of the internal carotids existed. Huermann has reported a case, in which the vertebral arteries were united by a transverse branch, a little below where they join to form the basilar artery. (Meckel.) In a case figured by Tiedemann (Tab. viii. fig. 3.), the right vertebral was preternaturally small; the posterior inferior cerebellic artery of the left side was larger than that of the right; while the anterior inferior artery of the cerebellum, on the right side, was much larger than that on the left,—the latter being represented by several small branches.

The inferior thyroid is subject to many anomalies in its origin. Sometimes it arises from the common carotid. (Nicolai, Haller, Vink, Böhmer, Neubauer, Huber, J. F. Meckel, Sen. and Jun., Tiedemann.) Neubauer and Meckel report a case in which it arose on the right side, from the arch of the aorta, between the innominata and the left carotid. Barclay met with an example in which both inferior thyroids proceeded from the aorta by a common trunk, and the left branch passed obliquely across the trachea, where it would have been divided in tracheotomy. Sometimes it consists of a single branch, which proceeds directly to the thyroid gland, the branches which are usually furnished by the thyroid axis to the neck being supplied by the subclavian. Sometimes the artery on one side is nearly obsolete (Haller), or it may be entirely wanting (Burns, Green). It may arise in common with the internal mammary, or the superior intercostal; or there may be a third inferior thyroid artery (*arteria thy roidia ima*, s. *Neubaueri*), which either arises from the arch of the aorta, the in nominata, or the primitive carotid. I have seen this anomaly, in several instances, under all these forms. It was first noted by Neubauer, and has since been observed by several anatomists, and by Godman.

The *supra-scapular artery*, which is generally a branch of the thyroid axis, sometimes proceeds from the subclavian or the transverse cervical. It passes sometimes in front—sometimes behind the scalenus anticus.

The *ascending cervical* is sometimes a branch of the subclavian, or the internal mammary.

The *profound cervical*, in a few instances, arises from the inferior thyroid, the superior intercostal, or even the vertebral.

The *transverse cervical* may arise either from the subclavian or the thyroid axis.

The *internal mammary artery* not unfrequently arises by a common trunk with the superior intercostal. Sometimes it arises in common with the inferior thyroid (Meckel, Green), and in rare instances, from the innominata (Neubauer), or directly from the arch of the aorta (Böhmer).

The *superior intercostal artery* sometimes arises in common with the internal mammary—rarely from the inferior thyroid (Sœmmering), and in some instances from the profound cervical. Green observed one case in which it proceeded

from the thoracic aorta. The varieties in its distribution have been already noted.

H. The *Axillary artery*, *arteria axillaria* (*Fig.* 2. *s*, *t*.) is the continuation of the subclavian, and according to the division made above, extends from the inferior margin of the second rib, to the termination of the fold of the axilla, or a level with the attachment of the latissimus dorsi and teres major muscles. The course of the artery, in its transit through the axillary region, is downwards, outwards, and backwards; and when the arm is by the side, it forms a gradual curve, having its convexity upwards and outwards,—its concavity downwards and inwards. The relations of the vessel are very complex throughout its whole extent, and should be carefully studied.

Where the artery is about to leave the side of the thorax, it reposes upon the intercostal muscle and the superior attachment of the serratus magnus. The axillary vein is in front of it, and when collapsed, a little beneath its level;—the brachial plexus of nerves is behind, and a little above. Accompanied by the vein and nerves, it glides outwards through a small triangular space, bounded internally by the walls of the thorax, superiorly by the clavicle or subclavius muscle, externally by the pectoralis minor,—and is covered in front by a lunated aponeurotic expansion, which extends from the ribs to the clavicle and coracoid process, denominated costo-coracoid ligament,—also by the pectoralis major muscle. Having traversed this space, it glides behind the pectoralis minor, a little below the point at which it becomes tendinous, still having the vein in front but lower down, while the several chords which form the brachial plexus of nerves interlace upon its surface, so as to form around it a kind of nervous sheath. Finally, after emerging from beneath the pectoralis minor, it continues its course outwards, reposing posteriorly upon the subscapularis muscle, which separates it from the capsular ligament of the shoulder joint, and courses along in front of the attachments of the latissimus dorsi and teres major, until it reaches the level of their outer margin, where it takes the name of brachial or humeral artery. In this part of its transit, the artery has the same relations with the vein as above. The two radicles of the median nerve, where they approach to unite with each other in front of the vessel, have the latter placed between them, one radicle of the nerve being on its radial, the other on its ulnar aspect. The external cutaneous nerve is also on its radial side, as is likewise the coraco-brachialis muscle. The internal cutaneous follows its ulnar side, and the radial and circumflex nerves gradually recede from it as they advance backwards. After the artery glides over the surface of the subscapularis muscle, it courses along the margin of the coraco-brachialis muscle, and upon the surface of the humerus, where, being superficially situated, it can be compressed against that bone. (See *Arm.*)

While coursing through this region, the axillary artery furnishes branches to the muscles of the thorax, the shoulder, and upper part of the arm, and the fat and glands in the axillary space.

From its internal part there are generally three or four branches given off, which are denominated thoracics, *r. thoracicæ.*

a. *Ramus thoracico-acromialis.* (*Fig.* 2. *u.*) This is generally a branch of considerable size, but varies much in this respect, according as the other thoracic branches take their origin from it, or from the axillary. It arises from the anterior part of the axillary artery, immediately on the inner side of the pectoralis minor, and divides directly into several branches, which proceed in different directions. Some of these, of small size, are distributed inwards, upwards, and forwards, to the serratus magnus and intercostal muscles, the subclavius, and the pectoralis major. The main branch advances outwards, upwards, and backwards, towards the space which separates the deltoid from the pectoralis major, and in front of the pectoralis minor. It divides into an ascending and a descending branch. The first advances towards the acromion process, sending small branches to the integuments of the shoulder and the deltoid muscle,—a branch which follows the course of the clavicle to its outer articulation,—and finally, several small branches, which plunge profoundly beneath the deltoid and the acromion process, and anastomose extensively upon the shoulder joint with the suprascapular, and circumflex arteries. The descending branch pursues the course of the cephalic vein, and is expended upon the deltoid and pectoralis major.

The thoracico-acromialis often gives off all the thoracic branches, and when it does so, it originates by a stout trunk, which immediately divides into a leash of branches.

b. *Ramus thoracicus supremus* (*Fig.* 2. *v.*) is generally a small branch, which, when it does not arise from the thoracico-

acromialis, comes off from the axillary, near the inner margin of the pectoralis minor. It descends in the space between this muscle and the pectoralis major, sending branches to both, and to the cellular tissue between them, and likewise to the serratus magnus and intercostal muscles. These branches anastomose with the internal mammary and intercostal arteries.

c. *Ramus thoracicus longus, s. externus.* (*Fig.* 2. *w.*) This branch, sometimes denominated *external mammary*, is larger than the preceding, with which it frequently takes its origin. In most cases, however, it arises from the axillary behind the pectoralis minor muscle, along the outer margin of which it descends, between the pectoralis major and the serratus magnus, gradually inclining inwards towards the side of the thorax. It sends branches to all these muscles, to the subscapularis, and glands and fat of the axilla, and finally to the intercostal muscles and mamma, where it anastomoses with the internal mammary artery.

d. *Ramus thoracicus alaris.* This is merely a small irregular branch, which, when it exists, arises near the middle of the axilla, or comes off from some of the other thoracic branches. It is distributed principally to the glands and cellular tissue of the axilla, and to the adjacent muscles.

The axillary artery having reached the outer edge of the subscapular muscle, gives off from its lower part a large branch, denominated

e. *Ramus subscapularis* (*Fig.* 2. *x.*), which is the largest of the vessels to which it gives origin. It descends about an inch parallel with the inferior costa of the scapula, accompanied by its corresponding vein, and after giving off several small ramifications to the glands and cellular tissue of the axilla, and the subscapularis muscle, divides into a descending and a posterior branch.

The first pursues the original course of the artery, and descends along the lower margin of the subscapularis muscle, towards the inferior angle of the scapula, sending numerous ramuli into its substance. It distributes, besides, branches of considerable size to the serratus magnus and latissimus dorsi,—small ones to the glands and cellular tissue,—and near the angle of the scapula, several are reflected backwards over the margin of the bone, to the teres minor and major, and to anastomose with the ramifications of its posterior branch, and the transverse cervical.

The posterior branch, *ramulus circumflexus scapulæ*, is larger than the preceding. It is reflected backwards, and turns round the lower margin of the neck of the scapula, in the space between the long head of the triceps, the latissimus dorsi and teres major, and the teres minor. It gives branches to the subscapularis,—one of considerable size to the latissimus dorsi, and others to the triceps, and teres major and minor. Having reached the posterior part of the scapula, it takes the name of *r. dorsalis scapulæ* (*Fig.* 10. *c.*), and divides into a superficial and a deep-seated branch. The first glides between the integuments and teres minor muscle, and supplies the superficial parts. The second runs profoundly between the infra-spinatus muscle and the bone, and ramifies extensively upon the dorsum of the scapula, anastomosing posteriorly with the posterior scapular artery, and inferiorly with the reflected ramifications of the subscapularis. It sends a considerable branch upwards, beneath the acromion process, into the fossa supra-spinatus, which anastomoses freely with the supra-scapular, the transverse cervical, and the thoracico-acromialis.

Still lower down, the axillary artery gives off the anterior and posterior circumflex branches.

f. *Ramus circumflexus posterior.* (*Fig.* 12. *b. Fig.* 10. *d.*) The posterior circumflex branch is larger than the anterior. It generally arises from the axillary artery just below the head of the humerus, but sometimes it is a branch of the subscapular, the superior profunda of the brachial, or of the anterior circumflex. Taking its course directly backwards, it twines around the upper part of the humerus, between the long head of the triceps and the bone, and through the space between the teres minor and major. It gives small ramuli to all these muscles, and having reached the posterior part of the arm, divides into ascending and descending branches. The first ascend over the attachment of the teres minor, towards the acromion process, and after sending numerous branches to the deltoid, ramify extensively upon the capsule of the joint, and anastomose with the thoracico-acromialis. The second descend towards the tendon of the deltoid, and after supplying that muscle, anastomose with the circumflexus anterior, and the profunda superior.

g. *Ramus circumflexus anterior.* (*Fig.* 12. *a.*) Smaller than the preceding, the anterior circumflex artery usually arises a little lower down. Sometimes, never-

theless, it comes off in common with it, and occasionally it arises from the subscapular, or the profunda humeri. It twines round in front of the bone, adhering intimately to its surface, beneath the coraco-brachialis and the short head of the biceps, and advances beneath the deltoid. It sends numerous ramuli to these muscles, and to the subscapularis. Near the bicipital groove of the humerus, it divides into ascending and descending branches. Of the former, the greater part are spent upon the capsular ligament of the shoulder joint, where they ramify and anastomose with the posterior circumflex, and the thoracico-acromialis. A few small ramuli, however, follow the course of the bicipital groove, and supply the synovial membrane. The descending ramuli pass downwards beneath the deltoid, supplying its substance, and anastomose below with the profunda superior and posterior circumflex.

I. *Arteria brachialis, s. humeraria.* At the lower border of the latissimus dorsi, the axillary takes the name of brachial artery, which is therefore merely a continuation of the great trunk already described. From this point, the vessel pursues a spiral course down the arm, inasmuch as where it approaches the elbow, it gradually winds forwards to reach the middle part of the anterior face of the bend of the fore-arm. Throughout its entire course, it reposes so close upon the bone, that it can be easily commanded by pressure. In the first part of its transit, it reposes upon the triceps muscle, and courses along the inner border of the coraco-brachialis; but from the point at which that muscle is inserted into the humerus, to the bend of the fore-arm, it reposes upon the brachialis internus, and follows the inner border of the biceps. In the upper three-fourths of the arm, it is covered by the integuments and brachial fascia; but a little above the elbow, it perforates that fascia, and descends into the bend of the arm beneath the strong aponeurotic expansion which is detached from the tendon of the biceps towards the ulnar side of the fore-arm. Having passed beneath this expansion, it sinks deep in the middle of the triangular space of the bend of the arm formed by the pronator teres and supinator longus, and about a finger's breadth below the joint, divides into the radial and ulnar arteries. (*Fig.* 13. *b.*) The artery is generally accompanied by two corresponding veins, between which it is placed, and several small transverse branches frequently pass across it in front, from the one vein to the other. The basilic vein also runs parallel with it, and is more superficial. In the upper part of the arm, the median nerve courses along its outer side, between it and the coraco-brachialis muscle,—sometimes immediately in front; but lower down, the nerve crosses obliquely in front of the artery, and gets on the ulnar side of it. High up, the ulnar, radial, and internal cutaneous nerves, are likewise placed upon its inner side, and are in such intimate relationship with it, as to render it more difficult to isolate the artery there, than lower down, where they recede from the vessel to advance towards the posterior and internal part of the arm.

Fig. 12.

a, Anterior Circumflex. *b*, Posterior Circumflex. *c*, Brachial. *d*, Profundus Superior. *e*, Profundus. *f*, Great Anastomotic. *g*, Radial. *h*, Lower Extremity of Radius. *i*, Carpal Ligament. *k*, Superficial Palmar Arch. *l* Ulnar.

In its course down the arm, the brachial artery supplies numerous branches, most of which are of small size, and only a few of them have had special appellations applied to them. Those which are small, and not distinguished by particular names, are merely distributed to the muscles and integuments situated in the vicinity of the brachial artery, and may be divided into external, anterior, internal, and posterior.

The *external branches* are neither large nor numerous. In the upper part of the arm, there is generally one or more distributed to the coraco-brachialis, and lower down, a few others, which glide into the space between the biceps and brachialis internus, and distribute their ramusculi to both those muscles.

The *anterior branches* are also small and irregular in their origin. Sometimes, however, there are three or four of considerable size distributed to the biceps muscle, and those which do not have this destination, are expended upon the integuments.

The *internal*, with the exception of

three presently to be described, are of small size, though sometimes numerous. Some of them, which come off high up, are distributed to the parts about the axilla,—especially to the pectoralis major and deltoid. Others take their course towards the adjacent portion of the triceps, in which they ramify extensively from the one extremity of it to the other.

The *posterior branches*, which are very small, are mostly expended upon the brachialis internus, but some of them reach the biceps, deltoid and triceps muscle.

The branches of the brachial artery to which particular names have been applied, are three in number:

a. *Ramus profundus superior, s. collateralis magnus.* (*Fig.* 12. *d.*) This branch, which is the largest given off by the brachial, occasionally takes its origin from the external circumflex or the subscapular. When it arises directly from the brachial, it comes off a little below the attachment of the latissimus dorsi, and taking its course backwards, twines round the posterior face of the humerus, between the bone and the long head of the triceps, accompanied in its transit by the musculo-spiral nerve. Having reached the outer part of the arm, it glides into the space between the triceps and brachialis internus, and becomes superficial. It then descends along the outer part of the arm, in the groove or depression between these muscles, towards the external condyle of the humerus; and a little above the elbow, divides into an anterior and a posterior branch. The first descends between the brachialis internus and the integuments, and after distributing numerous ramusculi to those parts, and to the supinators and the anterior part of the elbow joint, anastomoses with the radial recurrent. The posterior branch descends between the triceps and long supinator, sending branches to both those muscles, and then glides behind the external condyle of the humerus, where it distributes ramifications to the anconæus, and forms an extensive anastomosis with the interosseous recurrent. It also ramifies extensively upon the posterior face of the humerus, above the articulation; and one of these branches, larger than the others, takes its course across the posterior face of the bone, immediately above the fossa which receives the olecranon, and by anastomosing with the internal collateral, forms the *arcus dorsalis articularis*.

The external collateral ramus, in the first part of its course, gives off several ramifications to the triceps muscle, which are distributed extensively in the course of that muscle; and near the middle of the arm, it gives off the ramulus nutritius humeri, which enters the bone, and is expended upon the medullary membrane. This branch sometimes comes off directly from the brachial.

b. *Ramus profundus, s. collateralis inferior.* (*Fig.* 12. *e.*) The inferior collateral, or profound branch of the brachial artery, is much smaller than the superior. It arises ordinarily about the upper part of the inferior third of the arm, and proceeds directly inwards, along the anterior face of the brachialis internus, and behind the median nerve. In this course, it divides into two series of branches. The anterior run directly downwards in front of the internal condyle of the humerus, and between the brachialis internus and pronator teres, sending numerous ramusculi to these muscles and to the articulation, and anastomosing with the anterior ulnar recurrent. The posterior perforate the intermuscular ligament which separates the brachialis internus from the triceps, and thus arrive at the posterior internal part of the arm. They then send numerous ramifications to the triceps, and the posterior face of the humerus. One of the latter unites with a branch from the external collateral to form the arcus dorsalis articularis, as previously explained. The principal branch, however, descends in the space between the internal condyle and the olecranon, in company with the ulnar nerve, and after ramifying extensively upon the parts in the vicinity of the internal condyle, anastomoses with the posterior ulnar recurrent.

c. *Ramus anastomoticus magnus* (*Fig.* 12. *f.*) is rather a small branch, which arises from the posterior internal part of the brachial a little above the internal condyle. It advances directly inwards, between the brachialis internus and the median nerve, and having given off some small branches to the muscle, perforates the aponeurosis which separates the brachialis internus from the triceps. It then usually divides into two branches. One of these is expended upon the triceps,—the other descends between that muscle and the aponeurotic band already referred to, and anastomoses in the vicinity of the internal condyle with the inferior collateral, and the ulnar recurrent.

After giving off these branches, the brachial artery glides beneath the aponeurotic expansion sent by the tendon of the biceps to the ulnar side of the fore-arm, sinks deep in the triangular space situated

at the fold of the elbow, and on a level with the coracoid process of the ulna, divides into the radial and ulnar arteries (*Fig.* 13. *b.*), which separate from each other at an acute angle. Not unfrequently this division takes place higher up, and sometimes even in the axilla.

d. *Ramus radialis.* (*Fig.* 12. *g. Fig.* 13. *c.*) The radial artery is somewhat smaller and more superficial than the ulnar, and may be considered the continuation of the brachial, since it preserves the direction of that vessel. It descends upon the radial side of the fore-arm, in the direction of a line extending from the central point between the two condyles of the humerus to the articulation of the thumb with the trapezium, until it arrives on a level with the radio-carpal articulation, where it twines round the outer surface of the lower extremity of the radius, beneath the extensor muscles of the thumb, to reach the posterior part of the wrist. It then takes its course between the first and second metacarpal bones, and finally plunges directly forwards in the notch between these bones, to enter the palm of the hand, where it runs across the metacarpal bones to form the palmar arch.

Fig. 13.

a, Brachial. *b*, Division of Brachial. *c*, Radial. *d*, Recurrent Radial. *e*, Superficial Volar. *f*, Deep-seated Palmar. *g*, Uninn nf Radial and Ulnar. *h*, Ulnar. *i*, Posterior Recurrent. *k*, Interosseus. *l*, Communicans. *m*, Digitales.

In the upper third of the fore-arm, the radial artery reposes upon the tendinous portion of the short supinator and some filaments from the radial nerve, the latter being on its outer side, and somewhat removed from it. In the same region, it is in relation, on its ulnar side, with the pronator teres, while on its radial side, the long supinator is in contact and overlaps it to some extent. In the middle third of the fore-arm, it glides in front of the tendon of the pronator teres, and afterwards, upon the flexor longus pollicis and flexor sublimis. In the inferior third, it runs first over the surface of the pronator quadratus, and then reposes in immediate contact with the radius. Throughout the whole of this extent, it has the long supinator muscle on its outer side,—first its fleshy, and afterwards its tendinous portion. The radial nerve also runs parallel with it on the outer side. On its ulnar side, after passing over the pronator teres, it has the flexor carpii radialis muscle and its elongated tendon. It is accompanied by two corresponding veins, between which it marches; and in front, it is covered above, by the antibrachial fascia and the long supinator,—lower down, by the skin and fascia alone. The superficial radial vein, which is situated exterior to the antibrachial fascia, courses along the fore-arm, directly in front of the artery.

Between its origin and the wrist, the radial artery distributes a great number of small branches to the muscles and other parts in its vicinity, viz.: outwards to the supinators and radial extensors; inwards to the pronator teres and flexor carpi radialis; backwards to the flexor longus pollicis, flexor sublimis and profundus, and pronator quadratus; and forwards to the integuments. The only branches, however, which require a particular description, are the following:

α. *R. recurrens radialis.* (*Fig.* 13. *d.*) The recurrent radial branch is given off by the radial artery near its origin. It inclines outwards, and then upwards, forming a sudden curve, and runs in the space between the supinator longus and brevis, and the brachialis internus. It gives small ramusculi to all these muscles, to the common flexors of the fingers, and the radial extensors, and to the anterior part of the elbow joint. Its terminating branches ascend in front of the external condyle, to anastomose with the external profound branch of the brachial artery.

β. *R. superficialis volæ.* (*Fig.* 13. *e.*) About an inch above the carpus, where the radial artery begins to twine round the inferior extremity of the bone, it gives off the superficial volar branch, which varies much in size. It is sometimes so large as to represent the proper continuation of the radial artery, and in such cases, the superficial palmar arch is very large. In other cases, it is very small, and sometimes scarcely exists. It descends directly into the palm of the hand on its radial side, running in its course over the palmar aponeurosis, yet tied down by a slip of it, —then between the attachment of the

short flexor of the thumb, and terminates by uniting with the radial extremity of the superficial palmar arch formed by the ulnar artery, which it thus serves to complete. Small branches are furnished by it to the wrist, the muscles of the thumb, and the structures within the palm of the hand.

γ. *R. dorsalis carpi radialis.* This branch arises from the radial on a level with the external border of the tendon of the long radial extensor, about an inch above its attachment. It runs directly across the dorsum of the carpus, underneath all the extensor tendons, and anastomoses with a similar branch of the ulnar. From the arch thus formed, numerous branches are sent upwards to anastomose with the interosseous; others pass downwards to supply the integuments and interossei muscles, and anastomose with the perforating ramusculi of the deep palmar arch.

δ. *R. dorsalis metacarpi radialis* is given off immediately beyond the preceding, and sometimes arises in common with it, or the dorsalis pollicis. Its course is obliquely across the base of the metacarpal bone of the index finger to the back of the hand, and it sends ramusculi to the abductor indicis, the integuments, and the interosseii muscles.

ε. *R. dorsales pollicis* are two small branches which sometimes arise singly,—sometimes in common from the radial, just before it plunges into the space between the thumb and index finger. They proceed directly along the dorsum of the thumb, the one following the radial, the other the ulnar margin, anastomosing freely in their progress.

ζ. *R. dorsalis indicis* is a small irregular branch, which sometimes arises near the dorsalis pollicis. It takes its course along the dorsum of the radial margin of the index finger, and supplies small ramifications to the abductor indicis and the integuments.

η. *R. magnus, s. princeps pollicis.* After the radial artery has taken a turn forwards, to plunge into the palm of the hand, and while it is passing between the flexor brevis pollicis and abductor indicis, it gives off this branch, which proceeds directly forwards to a level with the base of the first phalanx of the thumb, and divides into two branches. One of these follows the radial, the other the ulnar border of the thumb, on its palmar aspect, to the tip, both branches being connected by frequent anastomoses.

ϑ. *R. radialis indicis* arises near the preceding, and follows the radial border of the index finger, first sending small branches to the abductor indicis and adductor pollicis, and anastomoses with the ulnaris indicis near the tip of the finger.

ι. *Palmaris profundus.* (*Fig.* 13. *f.*) This is the terminating branch of the radial artery. Having reached the palm of the hand, it sweeps across it, towards its ulnar margin, between the adductor pollicis, the tendons of the flexors of the fingers and the lumbricales, and the metacarpal bones, thus forming the profound palmar arch which has its convexity towards the fingers. This arch is placed near the posterior extremities of the metacarpal bones, and is completed by the union of the radial with the ulnar artery, near the metacarpal bone of the ring-finger. (*Fig.* 13. *g.*)

The profound palmar arch gives off numerous ramifications of small size. These are, 1. Several which come off from its concavity and proceed towards the carpus, to anastomose there with others furnished by the ulnar: 2. Others denominated perforating arteries, three in number, pass directly backwards, between the metacarpal bones, perforating the interosseii muscles, and anastomose posteriorly with the ramifications of the r. dorsalis carpi radialis: 3. Several branches proceed directly forwards from the convexity of the arch, which send ramifications to the interosseii muscles, and terminate at the anterior extremity of the metacarpal bones, by anastomosing with the digital branches furnished by the superficial palmar arch.

e. *Ramus ulnaris.* (*Fig.* 13. *h.*) The ulnar artery, which is larger and deeper seated than the radial, descends with a gradual curve along the ulnar side of the fore-arm, from the coronoid process of the ulna to the palm of the hand, where it terminates by forming the superficial palmar arch. In the upper third of the arm, where it is deep-seated, and covered by the pronator teres and superficial flexors, it descends obliquely towards the ulnar side of the fore-arm, forming at the same time a slight curve, the convexity of which is directed inwards and backwards. By this means it arrives fairly in front of the ulna, and at the point of union between the upper and middle thirds of the fore-arm, becomes superficial, and descends thence in a perpendicular direction towards the pisiform bone. Arrived at the wrist, it glides over the surface of the anterior annular ligament, along the radial side of the pisiform bone, covered by the palmar aponeurosis. Here, however, it

changes its course, and sweeps with a gradual curve across the palm of the hand, superficial to the flexor tendons, towards its radial margin, and unites with the r. superficialis volæ of the radial artery to form the superficial palmar arch.

In the upper third of the fore-arm, the ulnar artery is covered by the pronator teres, flexor carpi radialis, flexor sublimis digitorum, and palmaris longus. In the middle and inferior thirds of the fore-arm, it is situated in the space between the flexor carpi ulnaris on the inside, and the flexor sublimis digitorum and palmaris longus on the outer; consequently, while it is overlapped for a small distance above by the two first of these muscles, where they become tendinous, it is only covered by the integuments and brachial fascia, and in the palm of the hand by the palmar aponeurosis. At its origin, the artery reposes upon the brachialis internus, and is intimately connected with the median nerve, but is immediately afterwards separated from it by the ulnar origin of the pronator teres. Lower down, it reposes upon the flexor digitorum profundus, and this it continues to do, until it arrives at the wrist, where it rests upon the annular ligament, and while it is arching across the palm of the hand, upon the flexor tendons. In the whole of its course, it is placed between the two accompanying veins, but does not come in immediate relationship with the ulnar nerve, until it arrives at the junction between the superior and middle thirds of the fore-arm;—the nerve above that point, in consequence of its course behind the internal condyle, being considerably removed from it. From this situation, the nerve courses along the ulnar side of the artery, until it arrives at the carpus, but there gets a little behind the vessel.

The ulnar artery, like the radial, gives off an immense number of small ramifications to all the muscles in its vicinity, but most of them are too minute and unimportant to deserve names. The following branches only, require a particular description.

α. *R. recurrens ulnaris anterior.* The anterior ulnar recurrent is generally a small branch. It arises in most cases from the ulnar artery directly after its separation from the radial, but sometimes in common with the posterior recurrent. It passes inwards between the brachialis internus and the pronator teres, sends numerous ramifications to those muscles and the anterior part of the articulation, and then branches out extensively upon the anterior part of the internal condyle, where it forms a free anastomosis with the inferior profunda and the anastomoticus magnus.

β. *R. recurrens ulnaris posterior* (*Fig.* 13. *i.*) is much larger than the preceding, and arises nearly an inch lower down. It passes inwards and a little upwards, in front of the flexor digitorum profundus, and behind the pronator teres, flexor carpi radialis, palmaris longus, and flexor digitorum sublimis. Taking its course towards the inner condyle of the humerus, it divides into an anterior and posterior branch. The first ramifies extensively upon the anterior face of the condyle;—the second twines round the upper part of the ulna, in the space between the two attachments of the flexor carpi ulnaris, and thus reaches the posterior face of the condyle, where it passes in the depression between that body and the olecranon, in company with the ulnar nerve, and anastomoses with the anastomoticus magnus and inferior profunda.

γ. *R. interosseus.* (*Fig.* 13. *k.*) The interosseus is the third and largest branch of the ulnar artery. It arises from the posterior part of that vessel, a little below the level of the coronoid process of the ulna, whence it proceeds backwards and a little outwards, to gain the upper part of the interosseous space between the ulna and radius, and opposite the tuberosity of the latter bone, divides into an anterior and a posterior branch.

The first, denominated *r. interosseus anterior*, descends in a perpendicular direction upon the anterior part of the interosseous ligament, between the flexor longus pollicis and flexor digitorum profundus, distributing numerous small branches in its course to the adjacent muscles, and having arrived at the upper border of the pronator quadratus it sends branches into the substance of that muscle, which afterwards descend in front of the carpal bones, and anastomose with the anterior carpal ramifications of the radial artery. The main branch of the anterior interosseous artery, however, perforates the interosseous ligament on a level with the upper margin of the pronator quadratus, and descends posteriorly, between the radius and ulna, to the wrist, where it divides into numerous ramifications, which anastomose extensively with those of the posterior interosseous and the *r. carpi radialis.*

The *posterior interosseous artery* passes downwards and backwards, through the interosseous space between the upper

part of the interosseous and oblique ligament. It thus reaches the posterior part of the arm, and near the edge of the anconæus muscle, divides into two branches of nearly equal magnitude;—the posterior interosseous recurrent, and the proper posterior interosseous.

The *posterior interosseous recurrent* is reflected directly backwards and upwards; ascends between the short supinator and the anconæus muscles, then between the latter and the extensor carpi ulnaris, to the posterior part of the external condyle of the humerus, where it anastomoses with the radial recurrent and the profunda superior. Its branches are distributed to the short supinator, the anconæus, ulnar extensor, the triceps, and the structures surrounding the joint.

The *descending branch* is more superficially situated than the anterior interosseous, and does not like it repose upon the interosseous ligament, but follows the space between the common extensor of the fingers and the extensors of the thumb. It furnishes numerous ramifications of small size to all the muscles on the posterior part of the fore-arm, and near the wrist, divides into middle, external, and internal branches. The first anastomose with the branches of the anterior interosseal, the external with the *r. carpi radialis*, and the internal with the *r. carpi ulnaris.*

δ. *Ramuli carpi ulnares anteriores et posteriores* are small branches given off from the ulnar artery near the styloid process of the ulna. The anterior ramify extensively upon the front,—the posterior twine round the bone to the dorsum of the carpus, underneath the flexor and extensor tendons, and form a free anastomosis with the similar branches furnished by the radial artery.

The ulnar artery then continues its course over the carpal ligament (*Fig.* 12. *i.*) along the radial side of the pisiform bone, tied down by a slip of the palmar aponeurosis, and on a level with the base of the metacarpal bone of the little finger, divides into two terminating branches,—the *r. communicans*, and *r. palmaris superficialis.*

ε. *R. communicans, s. profundus.* (*Fig.* 13. *l.*) This branch, accompanied by a branch of the ulnar nerve, plunges profoundly into the ulnar side of the palm of the hand, by passing between the short flexor and the abductor muscle of the little finger, and inosculates with the palmaris profundus of the radial artery, to complete the deep palmar arch.

f. *R. palmaris superficialis.* (*Fig.* 12. *k.*) The superficial palmar branch of the ulnar artery turns outwards, with a gradual curve, across the palm of the hand, exterior to the flexor tendons, and having arrived at the middle of the metacarpal bone of the index finger, meets the superficial volar branch of the radial artery, and the radialis indicis, and thus forms the superficial palmar arch, the convexity of which is directed towards the fingers. This arch is placed more obliquely as regards the hand than the deep-seated one, and is also situated nearer the fingers.

From its concavity, small branches are given off, which pass upwards to the carpus, the annular ligament, and the lumbricales. They anastomose with the branches of the radial and ulnar arteries already described. The convexity of the arch gives origin to four branches of larger size, which pass directly forwards to the fingers, and are denominated

α. *Ramusculi digitales.* (*Fig.* 13. *m, m, m.*) The first digital artery courses along the ulnar margin of the hand, and after distributing small branches to the muscles and integuments surrounding the metacarpal bone of the little finger, is expended upon the ulnar side of that finger The second follows the space between the metacarpal bones of the little and ring fingers, and near their heads, divides into two branches, one of which supplies the radial side of the little finger,—the other the ulnar side of the ring finger. The third courses along the space between the middle and ring fingers, and divides, to send a branch to the radial side of the latter, and the ulnar side of the former. The fourth in like manner follows the space between the metacarpal bones of the middle and index fingers, and divides anteriorly to supply the radial side of the one, and the ulnar side of the other. The radial side of the index finger is supplied by the radial artery, as previously described.

In their course along the sides of the fingers, the digital arteries give off numerous small ramifications to their dorsal and palmar faces, which supply the soft parts, and form frequent anastomoses. Those which appertain to each finger are accompanied by branches of the ulnar and median nerves, and as they approach the anterior phalanx, they converge from opposite sides, and inosculate upon the middle of its palmar face, to form a small arch, from the convexity of which an infinity of delicate ramifications are given

off, which form a complex vascular network upon the ball or tip of each finger.

Varieties of the axillary and brachial arteries, and their principal branches:

It is not unusual for the thoracic arteries to arise by a common trunk. Sometimes one or more of them arise from the subscapular artery, and in rare cases, where there is a high bifurcation of the arteries of the arm, from the superior profunda, or even the radial artery. (Green.)

The *subscapular artery* seldom presents much variety in its origin. Monro has nevertheless remarked, that it sometimes arises from the inferior thyroid. (*Outlines of Anatomy.* III. 103.) Green has described an anomaly somewhat similar. "From the subclavian, just as it crossed the first rib, arose a very large vessel, dividing into all the thoracic arteries, and continued on to the scapula, to become subscapular." p. 15.

The *anterior* and *posterior circumflex arteries* sometimes arise by a common trunk. Sometimes one or both of them come from the superior profunda—sometimes from the subscapular, and occasionally, when the radial has a high origin, from that vessel.

Brachial artery. There is no part of the arterial system which presents so many anomalies as the brachial artery. They are indeed so numerous, that to describe them all in this place, would require more space than can be conveniently allotted to the subject. These anomalies consist mainly in the high origin of the arteries of the arm, and in the existence of irregular branches, denominated by Burns, *vasa aberrantia.*

In some cases, the brachial artery, instead of dividing in the bend of the arm, divides higher up. The point at which this division takes place varies. Sometimes it occurs a little above the elbow—sometimes about the middle or in the upper third of the arm, and occasionally within the cavity of the axilla. In some instances, the radial and ulnar arteries, after separating high in the arm, or in the axilla, pass for a limited distance down the arm, and again unite. The vasa aberrantia consist of branches of variable magnitude which arise from the brachial or subscapular arteries, and descend to unite below with either the radial, ulnar, or recurrent arteries,—more frequently with the former. Sometimes a large branch proceeds from the axillary and descends parallel with the brachial artery, to the internal condyle of the humerus, to anastomose with the ulnar recurrent. Occasionally a similar branch arises from the superior profunda. This condition may also exist with the origin of the profunda itself from the subscapular or its circumflex branch, or from the posterior circumflex. (Tiedemann. Tab. XIII., Barclay.)

The high bifurcation of the brachial artery is of so frequent occurrence, that it was described by Bidlo as the natural distribution. It has been estimated by Green, that the proportion of the irregular to the regular distribution, is as one to four, which accords with the observations of Harrison, who found varieties in the arteries of the arm in twenty-one out of eighty subjects.

When the high bifurcation takes place, the radial is more frequently the branch given off than the ulnar. Meckel remarks, that in twenty-two examples of high bifurcation in his possession, the radial artery was the branch given off in fourteen—the ulnar in only eight. (*Archiv. für Physiologie.* II. 124.) It should be remarked, however, that when the ulnar artery does take a high origin, it comes off generally higher up than the radial does under similar circumstances, and is oftener than that vessel given off in the axilla. (*Ibid.*) Only a few cases have been recorded in which the interosseous artery took its origin above the elbow.

The high bifurcation of these arteries often leads to important anomalies in their distribution.

The *radial artery*, when it takes its origin above the elbow, or in the axilla, generally runs parallel with the brachial, covered by the aponeuroses, as under ordinary circumstances, and pursues its usual distribution upon the fore-arm. Sometimes, however, it takes a superficial course, and runs over the tendinous slip of the biceps muscle. We have seen one case, in which the radial artery divided into two principal branches at the bend of the arm, one of which pursued the natural distribution, and furnished the superficialis volæ, while the other twined over the prominent surface of the supinator muscles, to the outer and posterior part of the arm, where it was expended upon the integuments and muscles. A much more common variety of this anomaly, is that in which the artery gives off the volar branch some distance above the wrist, and winds round the outer part of the radius. In such cases, the pulse cannot be felt at the wrist, or is preternaturally small. In some cases of high bifurcation, a transverse branch unites the

radial and ulnar in the vicinity of the bend of the arm, and occasionally the radial recurrent, and a median artery, which is distributed to the palm of the hand, are furnished from this branch. In some instances, there are two of these transverse branches, some distance from each other; and I have seen one, in which a union of this kind between the radial and ulnar, or rather between the radial and brachial artery, took place near the axilla. When the ulnar artery is given off above the usual point, the radial very often gives off the interosseous branch; and occasionally, under similar circumstances, the branch which is furnished by the radial, corresponding to the interosseous, passes superficially over the surface of the pronator teres to the ulnar side of the fore-arm, to supply the place of the ulnar artery, while the latter, after it emerges from beneath that muscle, descends in the natural course of the interosseous, and supplies its place.

The *ulnar artery*, when it comes off higher up than usual, is exceedingly irregular in its distribution. Sometimes it passes profoundly, as in the natural arrangement. More frequently, however, it runs immediately beneath the fascia of the fore-arm, over the surface of the pronator teres muscle. In some instances, both the radial and ulnar arteries pursue this superficial course to the wrist.

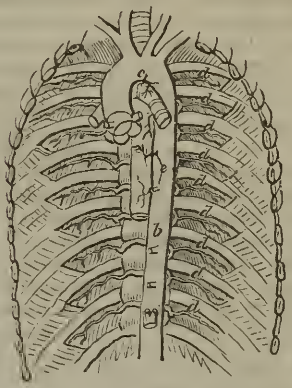
The interosseous artery, it has been already remarked, is generally a branch of the radial, when a high bifurcation takes place. Green saw two cases in which it terminated in the radial, where that artery is about to turn to the back of the thumb.

There is frequently a median artery, corresponding in its distribution to the vein of the same name. It may arise either from the radial, ulnar, interosseous, or humeral,—rarely from the last, but often from the interosseous. It descends to the palm of the hand, sometimes anastomosing with the branches of the superficial arch, occasionally joining the ulnar to form the arch, and supplying the place of the volar branch; in some cases supplying some of the digital branches on the radial side of the hand,—and finally terminating in the princeps pollicis. (Green.)

There are many other varieties of these vessels, which it would require too much space to enumerate. They are, indeed, nearly endless, and pursue almost every possible variety of distribution. The same remark may be made of the palmar arches, and the digital arteries, which so often depart from their normal distribution, that it would be vain to attempt to describe all their varieties.

The varieties in the origin and distribution of the arteries of the arm are exceedingly important, in relation to surgical operations, and especially in connexion with venesection. It is mainly from this cause that accidents so often happen in that operation, the anomalous course of the vessels rendering them very liable to be opened by the lancet.

Fig. 14.



b, Thoracic Aorta. *c*, Bronchial Arteries. *d*, Intercostals. *e*, Œsophageal.

The thoracic aorta (*aorta thoracica*, *s. descendens*) (*Fig.* 14. *b.*) is that portion of the vessel comprised between the termination of the arch and the diaphragm. It consequently extends from about the level of the fourth dorsal vertebra, to the twelfth, where it passes through the opening formed by the interlacement of the pillars of the diaphragm, and descends into the abdomen. In the whole of this course, it occupies the posterior mediastinum, and is placed upon the left side and in front of the bodies of the vertebra, inclining gradually towards the median line as it descends. Above, the root of the left lung is in front,—and lower down, the pericardium. On the left, it is in contact with the pleura of that side;—on the right, it is in relation with the thoracic duct, the vena azygos, and the œsophagus,—the latter, before it perforates the diaphragm, ranging in front of the artery to reach its left side. It is likewise accompanied by the pneumogastric nerves, and is only separated from the vertebræ by the intercostal veins of the left side.

All the branches furnished by the thoracic aorta are small, and may be divided

into anterior and lateral;—the first supplying the parts within the mediastinum,—the second, the intercostal spaces.

a. *Arteriæ bronchiales inferiores.* (*Fig.* 14. *c.*) The bronchial arteries are small and irregular, both as regards number and origin. There are generally from two to four, which arise separately from the aorta, about an inch below the termination of the arch; but sometimes there are only two, which come off by a common trunk, the latter dividing into a right and a left branch. Not unfrequently the right bronchial artery is a branch of the superior intercostal, or of the internal mammary. The left takes its course outwards, along the posterior face of the corresponding bronchus;—the right proceeds in an opposite direction behind the œsophagus, to the posterior face of the right bronchus,—and both pursue these tubes to their termination in the substance of the lungs, dividing, as they divide, into numerous ramifications, which twine upon the air-tubes, supplying their structures, and sending, besides, minute ramusculi into the parenchyma of the lungs, and to the pulmonary arteries and veins. They anastomose freely with the other vessels of the lungs. Near their origin, the bronchial arteries distribute small branches to the œsophagus, aorta, pericardium, and bronchial glands.

Besides these, the bronchi receive other branches of small size, either from the subclavian artery or the arch of the aorta, which are denominated *Arteriæ bronchiales superiores.*

b. *Arteriæ œsophageæ.* (*Fig.* 14. *e.*) These are small branches which arise from the anterior part of the aorta at variable distances below the origin of the bronchial arteries. They vary in number, from two to six or seven, and generally proceed forwards and a little downwards, to distribute their ramifications chiefly to the walls of the œsophagus; but in part also to the posterior mediastinum, and the coats of the aorta. Ramifications are sent upwards to anastomose with the branches of the bronchial and inferior thyroid arteries, while others proceed downwards, and anastomose freely with the phrenic and coronary artery of the stomach.

c. *Arteriæ mediastini posteriores.* The posterior mediastinal arteries consist of a number of very minute branches, derived in part from the anterior face of the aorta, but likewise from the œsophageal branches, and the intercostals. They plunge into the posterior mediastinum, sending also some ramifications to the coats of the aorta and the œsophagus, and form a very delicate vascular net-work, by their anastomoses with the œsophageal, thymic, and phrenic arteries.

d. *Arteriæ intercostales inferiores.* (*Fig.* 14. *d, d, d, d, d, d.*) The number of the inferior intercostal arteries varies, according as one, two, or three of the upper intercostal spaces are supplied from the superior intercostal, which is derived from the subclavian. Generally, there are eight or nine on each side, all of which proceed from the posterior lateral part of the aorta, the upper ones at an acute,—the lower at an obtuse angle. Those of the right side are longer than those of the left, because of the inclination of the aorta in the latter direction. The upper intercostals, moreover, ascend more than the lower, in consequence of their origin forming a more acute angle with the aorta. On the right side, each artery takes its course towards the intercostal space it is destined to supply, passing first in front of the vertebra, and behind the œsophagus, vena azygos, and thoracic duct,—then behind the sympathetic nerve, and between the pleura and the posterior extremity of the external intercostal muscle. On the left, the artery passes at once behind the sympathetic nerve, and between the pleura and intercostal muscle. In other respects, the distribution is the same on both sides. Arrived near the costo-vertebral articulation, each intercostal artery divides into a posterior and an anterior branch.

α. *Ramus dorsalis.* This branch is reflected backwards in the space between the corresponding transverse processes of the vertebra, and after sending small ramuli to those bones, and one or more which penetrate the intervertebral foramen to be expended upon the membranes of the spinal chord, it plunges into the mass of muscle placed in the groove by the side of the spinous processes, and anastomoses above and below with the ramifications of the intercostal arteries which are next to it in those directions.

β. *Ramus anterior* is the proper continuation of the intercostal artery, and is larger than the posterior branch. It advances in the space between the ribs which it is destined to supply, placed at first between the pleura and the external intercostal muscle,—then between the two muscles themselves. Pursuing this course for a short distance, it divides into an inferior and a superior branch.

The first, which is smaller than the other, inclines downwards towards the upper margin of the adjacent rib, along

which it runs for some distance, and finally advances in front of it, supplying ramifications to the periosteum, and the superficial parts in the vicinity.

The superior branch is much larger. It follows the groove which occupies the inferior margin of the rib, between its corresponding vein and nerve, until it reaches the anterior third of its transit, when it deserts the groove to follow the middle of the intercostal space. It gives branches to the intercostal muscles, the periosteum, pleura, and superficial muscles in the vicinity, and finally terminates by anastomosing with the next intercostals above and below. Those which belong to the true ribs, also anastomose anteriorly with the branches of the anterior intercostals of the internal mammary, while the anterior branches of those which appertain to the false ribs, reach the abdominal muscles, and anastomose with the internal mammary, the epigastric, phrenic, and circumflexus ilii.

The upper aortal intercostal, anastomoses above with the last intercostal furnished by the subclavian. The last one is concealed by the pillar of the diaphragm, to which it distributes branches: it then expends its ramifications upon the broad muscles of the abdomen, and sends several downwards between them, to anastomose with the lumbar and circumflexus ilii arteries.

The abdominal portion of the aorta (*pars abdominalis aortæ*) (*Fig.* 17. *.) reaches from the point at which that vessel emerges from between the pillars of the diaphragm, to the lower margin of the fourth lumbar vertebra, where it terminates by dividing into the right and left primitive iliac arteries (*Fig.* 17. *h.*), and the middle sacral (*Fig.* 17. *e.*). While the artery is gliding through the aortic foramen of the diaphragm, it is tied down firmly by the interlacement of the fibres of the crura of that muscle. On the twelfth dorsal vertebra, it reposes nearly on the median line of the spinal column: below that point it inclines a little to the left, presenting a slight concavity to the opposite side, but again reaches the median line where it divides. It is also convex forwards, to correspond with the curvature of this portion of the spine, against which it may be compressed in lean subjects, in cases of uterine or other forms of hemorrhage taking place from its branches, by directing the force backwards against the bodies of the vertebra.

On first entering the abdomen, the aorta has in front, the solar plexus of nerves, the stomach, and omentum minus: lower down, on a level with the second lumbar vertebra, it is crossed by the splenic vein and the pancreas, and immediately below the last organ, by the duodenum and left emulgent vein. From this point to its termination, it is placed behind the root of the mesentery. In its whole course through the abdomen, the nervous filaments twine around its surface, and invest it in an intricate plexus. On the right side, the aorta is in relation with the vena cava throughout, and in the upper portion of the abdomen, with the vena azygos and thoracic duct, which pass between it and the right pillar of the diaphragm: on the left, it is accompanied by the continuous trunk of the sympathetic nerve.

The arteries furnished by the abdominal portion of the aorta, may be divided into anterior and lateral.

The anterior branches are,

O. *Arteriæ phrenicæ, s. diaphragmaticæ inferiores.* (*Fig.* 17. *a.*) The phrenic arteries are very irregular as to their origin. They are generally the first branches given off by the aorta after it enters the abdomen, and either arise separately from that vessel, or by a common trunk which immediately divides into the right and left phrenic arteries. They are, nevertheless, often branches of the cœliac axis, and in some cases one or both of them take their origin from the superior mesenteric, emulgent, or one of the capsular arteries.

a. *Arteria phrenica dextra* proceeds upwards and outwards, over the margin of the corresponding pillar of the diaphragm, sending in its course small branches to that muscle, and to the supra-renal capsule (*r. supra-renales medii*). It glides behind the vena cava, and having reached the lower border of the cordiform tendon of the diaphragm, divides into an anterior and a posterior branch.

The *anterior branch*, which is the continuation of the artery, sends a small ramulus in front of the œsophagus, to anastomose with a similar one from the opposite side. It then glides between the diaphragm and the adherent portion of the liver, sends small branches into that organ, and continues its course upwards and forwards along the right side of the vena cava, in the vicinity of which it sends several small ramifications to that vein, as well as others which pass upwards to the pericardium. It finally distributes some of its ramifications to the costal portion of the diaphragm, some of which wind round the circumference of the cordiform tendon, to anastomose with the anterior

branch of the left phrenic; others range in an opposite direction, and anastomose with the posterior branch; while there are some which form an extensive anastomosis with the branches of the internal mammary, intercostal, and epigastric arteries.

The *posterior*, or *external branch*, is much smaller. It takes a transverse course above the liver, towards the right costal portion of the diaphragm, upon the fleshy digitations of which its ramifications are chiefly expended. It also distributes some small branches to the supra-renal capsules (*r. supra-renales superiores*), and anastomoses with the epigastric, intercostal, lumbar, and circumflexus ilii arteries

β. *Arteria phrenica sinistra* winds over the left pillar of the diaphragm, and pursues nearly the same order in its distribution as the right. Advancing upwards and forwards in an oblique direction, it detaches a considerable branch to the œsophagus, which ascends with it through the diaphragm, and anastomoses with the œsophageal branches. The artery then divides, like the right phrenic, into an anterior and an external branch, which are distributed precisely in the same manner as the artery of the right side, except that some of the ramifications of the external branch are expended upon the spleen.

Fig. 15.

a, Cœliac. *b*, Superior Coronary. *c*, Splenic. *d*, Right Gastro-epiploic. *e*, Hepatic. *f*, Pancreatico-duodenal. *g*, Left Gastro-epiploic.
1, Liver. 2, Gall-bladder. 3, Stomach. 4, Spleen. 5, Duodenum. 6, Pancreas.

P. *Arteria s. axis cœliaca.* (*Fig.* 15. *a. Fig.* 17. *b.*) The cœliac artery arises from the anterior face of the aorta where it emerges between the pillars of the diaphragm, and about the level of the point of junction between the last dorsal and the first lumbar vertebræ. It projects forwards, with a slight inclination downwards, to the extent of from a half to three-fourths of an inch, when it divides into three branches:—the *superior coronary artery* of the stomach, the *hepatic*, and the *splenic*, which represent a tripod arrangement. Sometimes, also, one or both phrenics are branches of this vessel, and occasionally the superior mesenteric likewise arises in common with it.

The cœliac artery is situated between the lesser curvature of the stomach and the diaphragm. In front, it has the gastro-hepatic omentum and the left lobe of the liver; on the right side, and a little upwards, the lobulus spegelii; on both sides, the semilunar ganglia and supra-renal capsules; and below, the superior mesenteric artery, the pancreas, and vena portarum. The solar plexus of nerves twines its filaments around it, which are likewise distributed upon its three branches.

a. *Ramus coronarius ventriculi, s. gastricus superior.* (*Fig.* 15. *b.*) The superior coronary artery of the stomach is the smallest of the three branches furnished by the cœliac, except when it furnishes the left hepatic ramulus, when it is often as large as the hepatic branch proper. From the cœliac axis, it proceeds upwards and forwards, inclining a little to the left, to reach the lesser curvature of the stomach on the right side of the cardiac orifice. It then passes between the two layers of the gastro-hepatic omentum, and divides into two branches, which may be denominated œsophageal and gastric.

The branches which are destined for the œsophagus pursue a different direction according to their situation. Some of them take a perpendicular course, and ascend with that tube upwards into the thorax, and besides sending numerous ramusculi to its walls, inosculate freely with the superior œsophageal branches. Others wind around the posterior circumference of the cardia, and send numerous ramifications downwards upon the greater extremity of the stomach, which anastomose with the branches of the splenic artery.

The gastric branch follows the lesser curvature of the stomach, between the two layers of the gastro-hepatic omentum, to the pylorus, where it terminates by anastomosing with the pyloric branch of the hepatic artery. In its course, it sends small ramifications to the lesser omentum, but is chiefly expended by a series of anterior and posterior branches, which descend upon the corresponding faces of the stomach, and anastomose freely with the branches of the gastro-epiploic artery, which follows the greater curvature of the organ.

b. *Ramus hepaticus.* (*Fig.* 15. *e.*) This, in the adult, is the second in size of the branches of the cœliac; but in the fœtus

it is even larger than the splenic. It ranges at first forwards, upwards, and towards the right side, between the portal vein and hepatic duct, behind the lesser lobe of the liver, and towards the pylorus. Arrived at this point, it ascends slightly, to reach the transverse fissure of the liver; but before arriving at that organ it divides into the right and left hepatic branches, which, surrounded by the capsule of GLISSON, plunge into its corresponding lobes, and expend themselves upon the intimate texture of the gland.

Before it reaches the liver, the hepatic artery furnishes the following branches:

α. *R. pyloricus, s. coronarius superior ventriculi dexter* usually arises from the hepatic a little to the right of the pylorus. It runs along the upper or concave curvature of the stomach, from right to left, and terminates in one or more branches which anastomose with the descending ramulus of the superior left coronary artery of the stomach. It also distributes ramifications to the pylorus, the anterior and posterior faces of the adjacent portion of the stomach, and to the pancreas. Some of these ramifications anastomose with the r. gastro-epiploica dextra.

β. *R. gastro-duodenalis, s. r. gastricus inferior dexter.* This branch generally proceeds from the inferior part of the hepatic, and descends behind the pylorus to the vicinity of the right extremity of the greater curvature of the stomach, and the posterior part of the second section of the duodenum. In this course, it gives several small branches to the pylorus, the upper part of the duodenum, and the adjacent portion of the pancreas. It then divides into two branches, denominated *pancreatico-duodenalis*, and *gastro-epiploica dextra.*

The *pancreatico-duodenalis* (*Fig.* 15. *f.*) is a small branch, which descends between the vertical portion of the duodenum and the head of the pancreas, sending ramifications to both these organs, and especially one branch, larger than the rest, which follows the posterior part of the pancreas towards its splenic extremity.

The *gastro-epiploica dextra* (*Fig.* 15. *d.*) is much larger than the preceding. It sweeps along the greater curvature of the stomach from right to left, between the two laminæ of the peritoneum which form the omentum majus, and about midway between the pylorus and spleen, terminates by anastomosing with the left gastro-epiploic branch of the splenic artery. It distributes numerous branches downwards to the omentum and the transverse arch of the colon, and others upwards, which ramify extensively upon both faces of the stomach, and anastomose with the branches of the pyloric and superior coronary of the stomach.

After the hepatic artery has reached the transverse fissure of the liver, and divided into a right and a left branch, it gives off the *ramulus cysticus*, to supply the coats of the gall-bladder.

γ. *R. cysticus.* This small ramulus arises from the right hepatic artery, and turning upon the neck of the gall-bladder, divides into two branches. One of them ramifies extensively upon the lower face of the vesicle, between the mucous and peritoneal coats; the other branches out between the liver and the gall-bladder, distributing ramifications to both.

c. *Ramus splenicus.* (*Fig.* 15. *c.*) This, in the adult, is the largest of the three branches given off by the cœliac. It ranges from right to left, below and behind the stomach, and along the upper margin of the pancreas, in the fissure or groove of which it is lodged. Its course is often very tortuous, and before reaching the fissure of the spleen, it furnishes the following branches:

α. *R. pancreatici*, irregular in number and size, which plunge into the substance of the pancreas, through which they ramify minutely, and anastomose with the branches sent to this gland by the pancreatico-duodenalis. There is sometimes one larger than the rest sent to the left extremity of the gland, which has received the appellation of *r. magnus pancreaticus.*

β. *R. gastro-epiploicus sinister, s. gastricus inferior.* (*Fig.* 15. *g.*) This branch is of considerable size. It first ascends slightly towards the greater *cul-de-sac* of the stomach, by which it is concealed,—then inclines forwards and downwards, and ranges from left to right, along the greater curvature of the stomach, and between the layers of the great omentum. It distributes several small branches to the pancreas; but its chief ramifications are those which it sends upwards to the anterior and posterior faces of the stomach, which anastomose with the superior coronary branch; and others which descend in the left half of the great omentum, and to the corresponding portion of the arch of the colon. About midway of the great curvature of the stomach, the gastro-epiploicus sinister terminates by anastomosing with the right gastro-epiploic branch.

γ. *R. splenici* are the proper terminal branches of the splenic artery. Before

the vessel reaches the fissure or hilus of the organ, it generally divides into two principal branches, which proceed between the two layers of the gastro-splenic omentum towards the fissure, and subdivide into a variable number of smaller branches. These latter are disposed in a series corresponding to the long axis of the organ which they penetrate, and then ramify and anastomose in a very intricate manner through its substance.

δ. *R. breves. Vasa brevia.* These branches vary in number, from three to six or seven. They proceed either from the trunk of the splenic artery, or from some of its branches, before they plunge into the substance of the organ. Inclining upwards and from left to right, they reach the greater *cul-de-sac* of the stomach, upon both faces of which they ramify, and approaching the cardia, anastomose with the œsophageal branches of the superior left coronary artery of the stomach.

Fig. 16.

a, Superior Mesenteric. *b*, Right Upper Colic. *c*, Right Middle Colic. *d*, Right Lower Colic. *e*, Ileo-colic. *f*, Rami Mesentericæ.

Q. *Arteria mesenterica superior.* (*Fig.* 16. *a.*) The superior mesenteric artery nearly equals the cœliac in size, and generally arises from the front of the aorta, about three or four lines below the origin of the vessel just mentioned. It extends from this point with a gentle curve, the convexity of which is to the left and forwards, to the right iliac fossa, where it terminates. The pancreas is placed above and in front of its origin, but it descends before the third section of the duodenum, and behind the transverse arch of the colon, to the upper extremity of the mesentery, where, engaging itself between the laminæ of that duplicature of the peritoneum, it pursues its course, inclining more and more towards the intestine as it descends.

Near its origin, the superior mesenteric artery furnishes several small ramifications to the pancreas, which anastomose with the branches sent to that gland by the hepatic and splenic arteries. The following, however, are its most important branches:

Branches which arise from the concavity of the superior mesenteric artery:

a. *Ramus colicus superior dexter.* (*Fig.* 16. *b.*) This branch is given off where the superior mesenteric passes the great transverse mesocolon. It glides in the space between the layers of that duplicature, towards the middle of the transverse arch of the colon, but divides at some distance from the intestine into a left and a right branch, which recede from each other at a very obtuse angle.

α. *R. anastomoticus sinister*, arising in this manner, sweeps along the direction of the left portion of the arch of the colon, and having reached the commencement of the descending portion of that intestine, anastomoses with the ascending branch of the superior left colic branch of the inferior mesenteric artery.

β. *R. anastomoticus dexter.* This branch arches round in the same way towards the right side, and terminates by a similar anastomosis with the ascending branch of the right middle colic. Both it and the preceding supply the portions of the colon and mesocolon to which they are distributed.

b. *Ramus colicus medius dexter.* (*Fig.* 16. *c.*) The general arrangement of this branch is very similar to that of the preceding. It generally arises lower down, but occasionally both branches come off by a common trunk, as represented in Fig. 16. In either case, it advances obliquely downwards, forwards, and towards the right side, and runs between the layers of the mesocolon to the vicinity of the middle of the ascending colon, when it divides into an ascending and a descending anastomosing branch.

α. *R. anastomoticus superior* sweeps round in the direction of the concave face of the colon, where it forms the commencement of the arch, and anastomoses with the right anastomosing branch of the vessel last described.

β. R. anastomoticus inferior passes downwards with a similar curve, along

the ascending colon, and forms an anastomosis with the ascending branch of the right inferior colic.

c. *Ramus colicus inferior dexter, s. ilio-colicus.* (*Fig.* 16. *d.*) This is a very large branch, and may be considered as the termination of the superior mesenteric artery. It arises a little lower down than the last—sometimes in common with it, and advances towards the right side, between the layers of the mesocolon, to the point of union between the ileon and cæcum, in the vicinity of which it divides into the three following branches:

α. *R. anastomoticus superior*, which ascends to anastomose with the descending branch of the right middle colic.

β. *R. anastomoticus inferior.* This branch glides into the fold of the mesentery, and forms an arch, by anastomosing with the mesenteric ramifications which are distributed to that structure.

γ. *R. ileo-colicus.* (*Fig.* 16. *e.*) The ileo-colic ramulus is intermediate between the two last, and arises from the angle formed by their division. It passes directly to the posterior part of the cæcum, where it is joined by the ileon. One branch is distributed to the fold of the peritoneum which invests the vermiform appendage, and supplies that process: another ascends along the posterior part of the colon, to anastomose with the vessels above; while a third distributes its ramifications to the anterior and posterior face of the cæcum and the ileo-cæcal valve.

Branches which arise from the convexity of the superior mesenteric artery:

d. *Rami mesentericæ, s. r. intestini tenuis.* (*Fig.* 16. *f.*) From the convexity of the superior mesenteric artery, fifteen or twenty branches are given off, destined to supply the whole of the small intestines, except the upper part of the duodenum. They descend from right to left, contained within the fold of the mesentery, towards the respective portions of the small intestines which it is their office to supply. The upper branches are short; those which are lower down, somewhat longer; while those which are the most inferior become again shorter. Each branch, after passing for some distance from its origin in the fold of the mesentery, divides into two, which recede from each other; the one turning upwards to form an arch by anastomosing with a ramulus sent off by the next branch above; the other turning downwards to form in the same manner, a similar arch below. From the convexity of these curves, which is directed towards the intestine, other branches arise, which divide and anastomose after the same manner to form a second series of arches, and by a succession of divisions and subsequent anastomoses, the series of curves are multiplied to three, four, or five, the ramifications of which become progressively smaller, but at the same time more closely interwoven with each other. Finally, having reached the junction of the mesentery with the intestine, a multiplicity of minute ramusculi twine around the anterior and posterior faces of the gut, between its tunics, and which by their anastomoses form rings which encircle it: they likewise constitute an extremely fine vascular network in the body of the mucous membrane and its villous arrangement.

Nearly the same arrangement is observed in the final distribution of the colic arteries. Generally, however, their branches do not form such an extensive series of arches; but after forming a complex vascular intertexture in the folds of the mesocolon, distribute their minute ramifications upon the circumference of the large intestines, around which they anastomose in the manner just described.

R. *Arteria mesenterica inferior.* (*Fig* 17. *f.*) The inferior mesenteric artery is not so large as the superior. It takes its origin, like that vessel, from the anterior part of the aorta, but much lower down; its origin being generally not more than an inch, or an inch and a half above the point at which the aorta divides to form the primitive iliacs. Descending with an oblique inclination towards the left iliac region, it glides first behind the peritoneum, until it reaches that portion of the mesocolon which binds down the sigmoid flexure of the colon, between the layers of which it insinuates itself; and having reached the brim of the pelvis, descends between the layers of the mesorectum, and behind the intestine, to the vicinity of the anus. Like the superior mesenteric artery, it forms a curve with its convexity directed to the left, but no branches are given off from its concave side, as is the case with that vessel. It sends off the following branches, to supply the left portion of the colon, and the rectum:

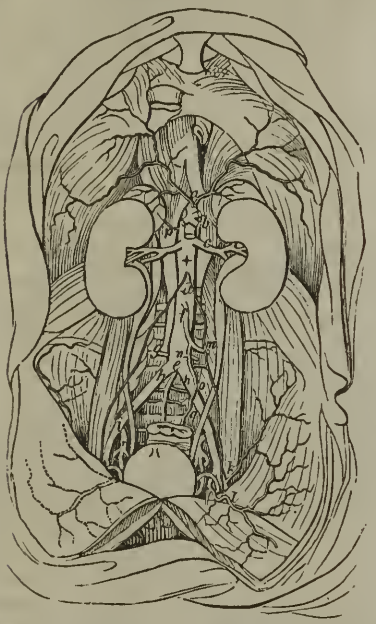
a. *Ramus colicus superior sinister.* (*Fig.* 17. *m.*) This, which is the largest of the branches of this artery, arises to the left of the bifurcation of the aorta, and takes its course outwards and a little upwards, in front of the left kidney, to the left mesocolon, between the laminæ of which it divides into an upper and a lower anastomosing branch.

α. *R. anastomoticus superior* inclines upwards to the arch of the colon, and terminates by anastomosing with the left anastomosing branch of the right superior colic.

β. *R. anastomoticus inferior* descends between the layers of the mesocolon, and anastomoses in a similar manner with the ascending branch of the middle colic, when that vessel exists, or with the corresponding branch of the left inferior colic.

b. *Ramus colicus medius sinister.* (*Fig.* 17. *n.*) This is generally a small branch,

Fig. 17.



*, Aorta. *a*, Phrenic Arteries. *b*, Cœliac. *c*, Emulgent. *d*, Spermatic. *e*, Middle Sacral. *f*, Inferior Mesenteric. *g*, Lumbars. *h*, Common Iliac. *i*, External Iliac. *k*, Circumflexus Ilii. *l*, Epigastric. *m*, Superior Left Colic. *n*, Left Middle Colic. *o*, Inferior Left Colic. *p*, Capsular Artery. *q*, Ioferior Hemorrhoidal.

and is often either wanting, or comes off from the superior left colic. It runs downwards and outwards to the mesocolon of the sigmoid flexure of the colon, and like the preceding, divides into an ascending and a descending branch.

α. *R. anastomoticus superior* ascends, and anastomoses with the descending or inferior branch of the superior left colic.

β. *R. anastomoticus inferior* descends, to anastomose with the superior branch of the inferior left colic.

c. *Ramus colicus inferior sinister, s. sigmoideus.* (*Fig.* 17. *o.*) This branch advances towards the sigmoid flexure of the colon, and like those described above, divides into an upper and a lower branch.

α. *R. anastomoticus superior* ascends, and anastomoses with the lower branch of the middle colic.

β. *R. anastomoticus inferior* inclines downwards and anastomoses with the ascending branch of the superior hemorrhoidal.

d. *Ramus hæmorrhoidalis superior, s. internus.* (*Fig.* 17. *q.*) The superior hemorrhoidal artery is the last or terminating branch of the inferior mesenteric. It runs downwards and inwards, engages itself between the layers of the mesorectum, and descends behind the intestine to the vicinity of the anus. It generally divides high up into two branches of unequal magnitude, the smaller of which sends a ramusculus upwards in the duplicature of the mesocolon, to anastomose with the inferior branch of the lower left colic. The larger branch divides about the middle of the sacrum into two equal ramifications, one of which descends upon each side of the rectum, and after distributing numerous small ramifications to the coats of that intestine, anastomoses freely with the middle and inferior hemorrhoidal, and the vesical branches.

The final distribution of the branches of the inferior mesenteric artery to the intestines, presents precisely the same arrangement as that observed in the branches of the superior mesenteric. As the pancreatico-duodenalis anastomoses with the first branch of the superior mesenteric, and the superior right colic branch associates that vessel with the inferior mesenteric, there is a continuous chain of vascular arches extending the entire length of the alimentary canal, so intimately connected by their extensive anastomoses, that whatever affects the circulation of one portion, must influence more or less that of the others.

S. *Arteriæ capsulares mediæ.* (*Fig.* 17. *p.*) The superior capsular arteries, which arise from the phrenic, have been already described. Those now to be noticed consist of from one to three small branches, which proceed from the lateral part of the aorta, above the origin of the emulgent arteries, and advance directly outwards across the pillar of the diaphragm, to the posterior part of the supra-renal capsules, upon which they are expended. They likewise send small branches to the pillar of the diaphragm, the lumbar glands, and sometimes to the upper part of the ureter. They are small in the adult, but during

the period of fœtal life their size is very considerable.

T. *Arteriæ renales, s. emulgentes.* (*Fig.* 17. *c.*) There are usually two emulgent arteries—one for each kidney; but sometimes the number is increased. They are so large, that it has been computed that they circulate one-eighth the whole mass of blood, and certainly their volume is proportionately greater than that of any other artery destined to supply a gland. They usually arise from the side of the aorta, a little below the origin of the superior mesenteric; but the right is situated somewhat lower than the left, in consequence of the position of the kidney on that side. It is also longer, on account of the aorta being placed on the left of the central line of the spine. Their direction is almost horizontally outwards, but they are inclined slightly backwards, and while both are overlapped by their corresponding veins in front, the right glides behind the vena cava to reach its point of destination. Having arrived at the notch or hilus of the kidney, each emulgent artery divides into three or more branches, which recede from each other, glide between the vein which is in front and the pelvis of the kidney and ureter, which are behind, and finally lose themselves in the substance of the gland. Previously to reaching the kidney, the emulgent artery gives off,—

a. *R. capsulares inferiores,* which take their course towards the suprarenal capsules: and

b. *R. adiposæ*, consisting of several minute ramifications which are distributed to the adipose substance surrounding the kidney, and sometimes in part to the pillars of the diaphragm.

U. *Arteriæ spermaticæ.* (*Fig.* 17. *d.*) The spermatic arteries, two in number, one for each side, are remarkable for their great length in proportion to their size, and for the tortuous arrangement presented by them near their termination. They arise, at an acute angle, from the anterior part of the aorta, a little below the emulgents, and above the superior mesenteric. Not unfrequently one of them is sent off above the level of the other; and sometimes one of them arises from the emulgent artery, and not from the aorta. They pass downwards, and slightly outwards, behind the peritoneum, and in front of the psoæ muscles, the ureters, and the iliac vessels, which they cross obliquely. The right spermatic artery also passes in front of the vena cava, and both of them distribute small ramifications to the adipose substance, lymphatic glands, and ureters; and when they have reached the brim of the pelvis, they present a different arrangement in the two sexes.

In the *male*, accompanied by the corresponding veins and the spermatic plexus of nerves, they advance towards the internal abdominal ring, where they are joined by the vasa deferentia, with which they pass downwards in the substance of the spermatic chord, through the inguinal canal, to reach to the testicle. They furnish several small branches to the chord and adjacent parts, and in the vicinity of the testicle, divide into two series of branches, one of which ramifies upon the epidydimis, while the other plunges into the substance of the gland, and supplies the tunica albuginea.

In the *female*, the spermatic arteries do not leave the cavity of the abdomen, but descend into the pelvis, approach the fold of the broad ligaments of the uterus, becoming there exceedingly tortuous, and expend themselves chiefly upon the ovaria. They also send ramifications to the Fallopian tubes, the broad and round ligaments, and a few of small size accompany the latter through the inguinal canal, and ramify in the fat and integuments of the labia.

V. *Arteriæ lumbares.* (*Fig.* 17.*g.*) The lumbar arteries are formed upon the same type, and are distributed precisely as the intercostals. They are somewhat larger than those vessels, but vary both as regards volume and number. There are seldom fewer than four lumbar arteries for each side, sometimes five,—but in rare instances there are only three. They arise from the posterior lateral part of the aorta, proceed outwards transversely across the bodies of the corresponding lumbar vertebra, behind the pillar of the diaphragm and the fasciculi of the psoæ muscles; and having arrived opposite the root of the transverse process, divide into an anterior and a posterior branch. The latter is reflected backwards between the transverse processes: it sends a branch through the intervertebral foramen into the spinal canal, which distributes its ramifications to the membranes of the spinal marrow, and the cauda equina. Other branches, of small size, are also distributed to the bodies of the vertebra and adjacent parts; but the termination of the posterior ramulus is upon the sacro-lumbalis, multifidus spinæ, and other muscles which repose upon the spinal column. The upper one

anastomoses with the posterior branch of the last intercostal; the lower with the ileo-lumbar.

The *anterior branch* of the first lumbar artery, which is small, follows the inferior margin of the last rib, sending ramifications to the attachment of the diaphragm, and after proceeding some distance, it inclines downwards, and is expended chiefly on the transverse muscle of the abdomen.

The *second* sends some small branches to the head of the psoas muscle, but is mostly spent upon the quadratus lumborum.

The *third* is much larger. It passes outwards, in nearly a horizontal direction, glides between the quadratus lumborum and the transversalis, to arrive in the vicinity of the crista of the ilium, where it terminates in two orders of branches, one of which is distributed to the broad muscles of the abdomen, while the other inclines towards the dorsum of the ilium, to ramify in the glutei muscles, and anastomose with the arteries of that region.

The *fourth* is also large. It passes directly outwards, between the psoas muscle and the quadratus lumborum, and near the lower attachment of the latter. In its course, it divides into numerous ramuli, some of which are distributed to the iliacus internus, while others reach the crista of the ilium, in the space between the broad abdominal muscles. Some of these are distributed to the transversalis and the two oblique muscles, forming at the same time a free anastomosis with the circumflexus ilii. The others wind over the crista of the ilium, and are expended on the glutei muscles.

Varieties of the branches which arise from the thoracic and abdominal aorta:

Bronchial arteries. In some cases there is only one bronchial artery, which divides into a right and a left branch. Occasionally there are three or four. The right bronchial artery arises so often from one of the right aortic intercostals, that Haller observed this arrangement in thirteen instances out of twenty-five. It is, moreover, not unusual for one of these vessels to arise from the internal mammary, the inferior thyroid, the innominata, or the subclavian. In some cases of morbus cærulius, the bronchial arteries have been found preternaturally enlarged. (Jacobson. Meckel's *Archiv. für Physiol.* II. 134. Tiedemann, *Zeitschrift für Physiologie*, I. 111.; and Otto, *Lehrbuch der Path. Anat.* I. 312.)

Intercostal arteries. The chief varieties of the intercostal arteries consist in the diminution or increase of the number of those which arise from the aorta, according as the intercostal ramulus furnished by the subclavian, supplies two, three, or more intercostal spaces. Sometimes, moreover, two intercostal arteries arise by a common trunk, which afterwards divides.

Phrenic arteries. These vessels are very liable to vary in their origin. In twenty-one cases examined by Haller (*Icon. Anat.* Fasc. iii. p. 53.), the phrenic arteries arose by a common trunk from the aorta, in three: in the same manner from the cœliac, in two; and in sixteen, the two vessels had a separate origin. In six of these, both arteries arose from the cœliac; in two, from the aorta. In two, the cœliac artery furnished the right;—the aorta the left. In two, the right arose from the coronary artery of the stomach; the left from the aorta. In two, the aorta furnished the right; the cœliac the left. In one, the right arose from the emulgent; the left from the cœliac: and in one, there were four phrenic arteries, two of which took their origin from the aorta, and two from the cœliac artery. Lieutaud saw one case, in which the right phrenic took its origin from the first lumbar artery; and in an instance observed by Green, the phrenic arteries arose by a common trunk above the diaphragm, which descended through the aortic foramen, and divided into two branches. He also saw the left phrenic detached from the aorta below the superior mesenteric; and in another example, there were three phrenic arteries; one from the aorta, on the left side; on the right, a common trunk from the renal, divided into right and left phrenics. (*Op. Cit.* p. 24.)

Cœliac artery. In some cases, the cœlia axis is wanting, the three branches into which it usually divides taking their origin separately from the aorta. (Otto. *Seltene beobachtung.* I. 101.) Sometimes the coronary artery of the stomach forms a common trunk with one of the phrenics, which arises from the aorta. Not unfrequently the same artery furnishes the left hepatic ramulus, while the right arises from the cœliac or superior mesenteric. An example of the last variety has been reported by Meckel. (*Handb. der Path. Anat.* II. 121.) In such cases, the cœliac artery only furnishes two branches. Sometimes there are two hepatic arteries,—one from the cœliac, the other from the aorta. In addition to these two, there may be a third from the superior mesenteric artery. Occasionally, the trunk of the hepatic artery proceeds directly from the aorta

(Meckel), or from the superior mesenric artery (Haller). Green also reports a case, in which there were three hepatic arteries;—one from the cœliac, in common with the coronary of the stomach; a second from the same artery, in common with the right gastro-epiploic; and a third from the superior mesenteric, which gave off the cystic artery. In one case, the cœliac artery divided into four branches,—the three which are natural to it, and the right gastro-epiploic artery, the latter of which, about an inch from its origin, united with a branch of the hepatic artery, so as to form with it a right-angled triangle. (Weber, in Hildebrandt's *Handbuch der Anat.* III. 230.) Another anomaly of this kind is that in which the cœliac furnishes the superior mesenteric artery. In a case reported by Petsche, the cœliac divided into three branches, but that which corresponded to the hepatic artery was distributed to the right renal capsule, and the liver was supplied by the superior mesenteric. In some instances, a small branch of the emulgent artery is expended upon the liver. Mills has reported a case in which the hepatic artery was wanting. (Green. *Loc. Cit.* p. 25.)

The *superior mesenteric artery.* This artery sometimes arises from the cœliac, as was remarked above; and not unfrequently it comes off so near that vessel, as to present the appearance of a common origin. Velse reports a case, in which the superior mesenteric artery was double, one branch taking its origin directly below the other. (Haller. *Diss. Anat.* VII. 155.) In a monster which was examined by Wehrde, the superior mesenteric, sacro-medial, and the left umbilical arteries were wanting. (*Dissert. anat. path. de monst.*, &c. Halæ, 1826.) In a case observed by Vicq D'Azyr, there was no anastomosis between the superior and inferior mesenteric arteries.

Emulgent arteries. Varieties of these arteries are of frequent occurrence. They consist, for the most part, either in an increase in number, or an unusual origin of one or both vessels. The number is sometimes increased by the emulgent artery dividing into more branches than usual before it enters the kidney; but cases are not uncommon, in which there are from two to five emulgent arteries, for one or both glands, which take their origin separately from the aorta or some other vessels. Eustachius has figured several examples of this anomaly (*Tab. Anat.* Tab. xii. figs. 9, 10, 11.), and many others have been since reported by different individuals. The supernumerary vessels may all arise from the aorta, or in part from it and the common iliac, the internal iliac, or the middle sacral. In one of the cases figured by Eustachius, both kidneys received three arteries, two of which had their origin from the aorta some distance apart, while the third proceeded from the left common iliac. It is more particularly when the kidney is situated lower down than usual, that these accessory emulgent arteries are apt to take their origin below the ordinary point. Two cases were observed by Otto (*Path. Anat.* p. 312.), in which an emulgent artery arose from the middle sacral artery;—in one on the right, and in the other on the left side. Another instance is reported by Boinet, in which the right kidney, placed transversely within the pelvis, had the middle sacral artery distributed to it. (*Archives Générales.* Fev. 1835.) A still more singular anomaly was furnished by a case observed by Portal: both emulgent arteries had their origin by a common trunk from the anterior part of the aorta. This divided into a right and left branch, each of which proceeded to its proper point of destination. (*Cours d'Anat. Médicale.* III. 290.) In many instances in which there are supernumerary emulgent arteries, some of them do not enter the hilus of the gland, but plunge directly into some part of its surface.

The *spermatic arteries* vary considerably in their origin. Very often one of them arises from the aorta much lower than the other. They occasionally proceed from that vessel by a common trunk; and not unfrequently one of them arises from the emulgent artery. Sometimes, also, one of them proceeds from the capsular artery (Haller), from the external iliac, the hypogastric (Mayer. *Beschreib. des Blutgef.* p. 180.), one of the lumbar, or even the epigastric (Meckel). In some instances the spermatic artery is double, upon one or both sides. (Haller, Morgagni, Hunter, Pohl, Nicolai, Huber, Otto.) This happened in two cases observed by Otto, in both of which each artery was double. (*Seltene Beobacht.* I. 101.)

Lumbar arteries. The principal anomalies of the lumbar arteries consist in the origin of two or more of them by a common trunk. In some cases, when the inferior intercostal artery is very large, it supplies the place of the first lumbar; and in like manner, the inferior lumbar is sometimes furnished by the ilio-lumbar.

Inferior mesenteric. This artery is

rarely wanting; yet an example has been reported by Fleischmann (*Leichenöffnungen*, 239. No. 81.) in which this vessel was absent, and had its place supplied by the superior mesenteric artery. But the most singular anomaly of this vessel is one described by Petsch. (*Syllog. observ. anat. select.* § 76.) The right kidney was wanting: the aorta, after giving off the left emulgent artery, divided into the two primitive iliacs, from the left of which the inferior mesenteric artery took its origin; and below this point, the two iliac arteries were united by a transverse branch.

Fig. 18.

a, Aorta. *b*, *b*, Common Iliacs. *c*, Internal Iliac. *d*, External Iliac. *e*, Ilio-lumbar. *f*, Lateral Sacral. *g*, Middle Hemorrhoidal. *h*, Umbilical. *i*, Vesical. *k*, Obturator. *l*, Gluteal. *m*, Ischiadic. *n*, Pudic. *o*, Epigastric. *p*, Circumflexus Ilii. *q*, Middle Sacral.

W. *Arteriæ iliacæ communes.* (*Fig.* 17. *h. Fig.* 18. *b.*) The common, or primitive iliac arteries, are two large vessels formed by the bifurcation of the aorta, at the inferior margin of the fourth lumbar vertebra. They separate from each other at an acute angle, and supply the whole of the parts within and exterior to the pelvis, as well as the lower extremities. In the female, the angle formed by their separation is wider because of the greater dimensions of the pelvis; but in both sexes, they incline obliquely downwards, outwards, and a little forwards, covered by the peritoneum, until they arrive in front of the sacro-iliac symphisis, where they divide into a posterior and an anterior branch (*Fig.* 18. *c*, *d.*), which are the internal and external iliacs,—the first of which is appropriated chiefly to the organs and walls of the pelvis; the second to the lower extremities. The two primitive iliac arteries, though of equal size, differ somewhat in their relations. They are both placed behind the peritoneum, and crossed obliquely by the ureters, as the latter descend into the pelvis. They likewise have the psoas muscles upon their outer side and a little posterior. The right iliac is a little longer and more curved than the left, because of the situation of the bifurcation of the aorta to the left of the middle line of the vertebra. It is crossed by the lower part of the ileon, where it is about to join the cæcum, and the vermiform process is in front of it. In its course, it glides in front of the commencement of the cava, and of the left iliac vein, which is placed posterior, and to the left of the artery. The left iliac has the termination of the sigmoid flexure of the colon and the commencement of the rectum in front, and the left iliac vein inwards and posteriorly. It pursues a straighter course than the right, and, consequently, ranges more in the direction of the axis of the aorta. Neither of them furnish any branches previous to their division into the internal and external iliacs, with the exception of some very minute ones to the peritoneum, glands, cellular tissue, and other adjacent parts. A branch, however, comes off in the bifurcation of the aorta, which descends midway between these vessels, and must be described previously to tracing out the distribution of the internal iliac. It is denominated

X. *Arteria sacra media.* (*Fig.* 17. *e. Fig.* 18. *q. Fig.* 21. *b.*) At its origin, it is nearly as large as one of the lumbar arteries. It descends along the middle of the anterior face of the sacrum, to the extremity of the coccyx, having the rectum and superior hemorrhoidal artery in front. At its termination, it reflects a small branch outwards on each side, which, anastomosing with similar branches of the lateral sacral, forms a kind of vascular arch on the right and left sides, and in front of the coccyx. In its course, the middle sacral artery distributes small branches to the rectum, which anastomose with the hemorrhoidal arteries; and besides these, several others which range outwards transversely, in front of the several segments of the bone, and near the anterior sacral foramina, anastomose with similar branches from the lateral sacral arteries. Small branches also penetrate these foramina, to supply the sacral nerves; others are distributed to the substance of the bone; and the upper transverse branch generally anastomoses with the ilio-lumbar, and sometimes supplies the place of one of the lumbar arteries.

Y. *Arteria iliaca interna, s. hypogastrica.* (*Fig.* 17. *r. Fig.* 18. *c.*) The relative size and the distribution of this artery, differ so much in the fœtus and the adult, that

it will be proper to describe the arrangement it presents at both these periods of life.

In the adult, it descends in nearly a perpendicular direction in front of the sacro-iliac symphises, from the upper part of that articulation to the sacro-sciatic notch, where it seems to terminate by dividing into branches. Very commonly, however, shortly after its origin it resolves itself into two principal divisions,—one anterior, the other posterior, from which all the other branches derive their origin. When this is the case, the anterior furnishes the ischiatic, internal pudic, hemorrhoidals, uterine, vaginal, vesical, and umbilical branches; the posterior, the ilio-lumbar, lateral sacral, gluteal, and obturator. In its course, the internal iliac artery has its corresponding vein; the communicating branch of the lumbar plexus of nerves and the pyriform muscle behind; the sacral plexus of nerves upon its inner side; the psoas muscle on its outer side, above; and the ureter ranging obliquely in front of it, near where it separates from the external iliac. Its branches are numerous, and exceedingly irregular in their origin.

a. *Ramus ilio-lumbalis.* (*Fig.* 18. *e.*) The ilio-lumbar branch is the first of any importance given off by the internal iliac artery. It arises from the posterior part of that vessel, in front of the sacro-iliac symphisis, and proceeding outwards, backwards, and slightly upwards, behind the psoas muscles and the external iliac vessels, and in front of the communicating branch of the lumbar plexus of nerves, it divides on a level with the base of the sacrum, into ascending and transverse branches.

The *ascending* branches mount upwards, distributing ramifications to the psoas, iliacus internus, and quadratus lumborum muscles. It also sends some small branches through the intervertebral foramina, to the cauda equina, and forms a free anastomosis with the last lumbar artery.

The *external* branches are superficial and deep-seated. The first pass outwards between the peritoneum and the iliacus internus, sending ramifications to both these parts, as well as to the psoas: some of them reach the crista of the ilium, and terminate there in the broad muscles of the abdomen. The deep-seated ramify in the substance of the iliacus internus, and supply the periosteum: one of them penetrates the nutritious foramen of the bone, to supply its reticulated texture. Some of them advance along the crista of the ilium, and anastomose freely with the circumflexus ilii and the gluteal arteries. Sometimes a few branches also descend along the psoas and iliacus internus muscles, to the vicinity of the crural arch, and anastomose with the epigastric and obturator arteries.

b. *Ramus sacri lateralis.* (*Fig.* 18. *f.*) The lateral sacral artery generally consists of a single small branch; but sometimes there are two or more, which run parallel with each other. It usually arises from the inner part of the internal iliac, but occasionally from the ilio-lumbar or the gluteal. It descends along the anterior face of the sacrum, in the direction of the line of the anterior sacral foramina, and about an inch from the middle sacral, with which it runs parallel. Converging slightly towards the centre as it advances, it reaches the coccyx, and there turns inwards, to anastomose in form of an arch with the middle sacral, and the corresponding branch of the opposite side. It is placed in front of the pyriform muscle, and the roots of the sacral nerves, to which it gives small branches: it likewise distributes several small ramuli to the anterior face of the sacrum, which supply the periosteum and sacral ganglia, and anastomose with the ramifications of the middle sacral. Posteriorly, it gives off a branch for each anterior sacral foramen, which having penetrated its proper opening, divides into an anterior and a posterior ramulus. The first is expended upon the sacral canal and the cauda equina; the second proceeds backwards through the posterior sacral foramen, and is distributed to the deep-seated muscles of the back.

c. *Ramus hæmorrhoidalis medius.* (*Fig.* 18. *g.*) This is generally a small and irregular branch, which proceeds as often from the gluteal, or the ischiadic, as from the internal iliac. It runs downwards and forwards, between the rectum and *bas fond* of the bladder in the male, and between the former and the vagina in the female. It distributes numerous small branches to these parts, to the vesiculæ seminales, and the prostate gland. Some are likewise reflected upwards, to anastomose with the superior hemorrhoidal branch from the inferior mesenteric; while many others form free inosculations, near the anus, with the inferior hemorrhoidal, which arises from the internal pudic.

d. *Ramus umbilicalis.* (*Fig.* 18. *h.*) The condition of this branch is very different in the fœtal state from that which

it assumes after birth. In the first, it seems to be the continuation of the internal iliac artery, which turns upwards, forwards, and inwards, along the superior lateral part of the bladder;—thence taking its course obliquely upwards, along the posterior face of the abdominal muscles, invested in a fold of the peritoneum, it meets its fellow at the umbilicus, and both of them passing through that opening, pursue their course along the umbilical chord to the placenta. At this period of life, therefore, where it ascends by the side of the fundus of the bladder, it forms an arch with its convexity looking downwards, from which the principal branches distributed to the pelvic organs take their origin.

After birth, the relative size of this vessel undergoes a very striking diminution, and all that portion of it between the fundus of the bladder and the umbilicus becomes obliterated, and is converted into a round compact chord, denominated umbilical ligament, which is contained within a duplicature of the peritoneum. The only branches it furnishes at this period are, the superior vesical branches to the fundus of the bladder, and in the female, a few to the uterus.

e. *Rami vesicales.* (*Fig.* 18. *i.*) The vesical arteries are exceedingly variable as to number, and the source from which they have their origin. The bladder, indeed, receives blood from several sources, as the pudic, the obturator, hemorrhoidal, and other arteries: but besides these, it has others which are for the most part proper to it. These may be divided into superior and inferior.

The *superior* vesical branches arise from the umbilical artery where it advances along the side of the fundus of the bladder. They ramify extensively upon the adjacent portion of that organ, some of them descending towards its neck.

The *inferior* vesical branch generally arises from the internal iliac, but sometimes from the gluteal or ischiatic. It follows the course of the ureter, glides between the coats of the lower fundus of the bladder near where that tube penetrates it, and expends itself upon the neck and adjacent portion of the organ, the vesiculæ seminales, vas deferens, prostate gland, and the neighbouring part of the rectum.

f. *Ramus uterinus.* The size of the uterine artery varies at different periods of life, and is especially influenced by the condition of the organ itself. During childhood it is relatively small; but when the uterus takes on its proper functions, at the age of puberty, and especially in its impregnated state, it becomes very large, and exceedingly tortuous in its distribution. It arises from the internal iliac artery—sometimes from the umbilical, gluteal, ischiadic, pudic, or hemorrhoidal branches of that vessel. Inclining forwards by the side of the upper part of the vagina, it sends branches to that organ, to the adjacent portion of the bladder, and the mouth of the uterus: it then engages itself between the fold of the broad ligament, runs in a tortuous direction towards the organ it is intended to supply, into which its branches plunge and ramify extensively, forming at the same time a free anastomosis with their fellows of the opposite side. Other branches are distributed to the Fallopian tubes and ovaria, and inosculate freely with the spermatic artery.

g. *Ramus vaginalis.* This is generally a small branch, and not unfrequently its place is supplied by some other. Like the preceding, it may arise either from the internal iliac, the ischiadic, pudic, or hemorrhoidal. It descends upon the anterior lateral part of the vagina, supplying numerous branches to that organ and the neighbouring parts of the bladder and rectum. Having arrived at the external parts of generation, it is expended upon them, and forms there an extensive anastomosis with the internal pudic artery.

h. *Ramus obturatorius.* (*Fig.* 18. *k.*) The obturator artery, though constant in its existence, is far from being so as regards its origin. Proceeding most frequently from the internal iliac, cases are not rare in which it arises either from the gluteal, ischiadic, epigastric, external iliac, or even the femoral artery. When it is a branch of either of the last named vessels, its course and relations are materially changed;—it descends in nearly a perpendicular direction to reach the obturator foramen, and as it runs in the immediate vicinity of the crural ring, it will, when such a distribution exists, in the event of a hernia being produced, course around either the posterior internal, or the anterior parts of the neck of the sac. (See *Abdomen*, Surg. Anat. and Varieties of the present head.)

When the obturator artery arises from the internal iliac, it courses downwards, forwards, and outwards, along the inner surface of the lateral wall of the pelvis, and a little behind the obturator nerve, with which it advances towards the upper portion of the thyroid foramen. It then

glides over the obturator internus muscle, and in company with the nerve passes through a small round aperture in the upper portion of the obturator ligament, after which it immediately divides into two series of branches,—the one posterior, the other anterior. In its course to this point, the artery gives a small branch outwards, which twines over the brim of the pelvis, and is expended upon the iliacus internus muscle: others of small size, to the bladder, prostate, obturator muscle, and the neighbouring lymphatic glands; and one which mounts upwards along the posterior face of the symphisis pubis, where it sends ramifications across to anastomose with the vessel of the other side, and a few which take their course outwards, to inosculate, near the crural ring, with the branches of the epigastric.

The *posterior branches* of the obturator artery course along the external margin of the thyroid foramen,—sometimes between the two obturator muscles, but occasionally over the surface of the external. They send numerous ramifications to these muscles and to the adductor magnus: some glide through the notch of the acetabulum, to supply the structures within that cavity; but the chief branches wind round between the acetabulum and the tuber of the ischium, to reach the posterior part of the hip joint, where they terminate upon the adjacent structures, forming at the same time a free anastomosis with the descending branches of the ischiadic.

The *anterior*, or *internal branches*, which terminate the obturator, wind round the inner margin of the thyroid foramen, in the space between the adductor longus and the adductor brevis. They inosculate extensively with the ramifications of the internal circumflex, and supply numerous branches to all the neighbouring muscles, some of which descend for some distance down the thigh, while others incline backwards towards the posterior part of the member.

i. *Ramus glutæus, s. iliacus posterior.* (*Fig.* 18. *l.* *Fig.* 20. *a.*) The gluteal is a very large branch, and in the adult may be considered the continuation of the internal iliac. It either arises separately from the posterior portion of that vessel, or in common with the ischiadic. It inclines at first downwards and backwards, having the iliac artery and vein, and the lumbo-sacral nerve, in front; but when it arrives at the level of the upper margin of the sacro-sciatic notch, it then turns backwards and outwards beneath the bone, and between the pyriformis and gluteus minimus muscles. In making this sweep, the artery forms a curve with its convexity downwards, and having fairly escaped from the cavity of the pelvis, and arrived upon the dorsum of the ilium, in the space between the gluteus medius and gluteus maximus, it there divides into a superficial and a deep-seated branch. While in the pelvis, however, it distributes several small branches to the pyriform, obturator, and levator ani muscles, and sometimes gives origin to some of the branches already described.

α. *R. superficialis* (*Fig.* 20. *i.*) is the smaller of the two. It runs outwards and upwards between the gluteus maximus and medius, sending in the first place several small branches to the sacro-sciatic ligament, the adjacent portion of the sacrum, the coccygis, and the lower part of the longissimus dorsi muscle:—some of these anastomose with the ischiadic and pudic branches. The superficial ramulus then pursues its course between the gluteus maximus and medius, and is chiefly expended upon them.

β. *R. profundus.* (*Fig.* 20. *c.*) This is the principal branch of the gluteal artery; and it ramifies so extensively as to supply all the parts upon the dorsum of the ilium. It first sends one or two nutritious ramusculi which penetrate the substance of the bone: then it generally divides into three series of ramifications, which may be denominated superior, middle, and inferior. The first sweep forwards with a gentle curve, between the gluteus medius and minimus, and towards the anterior superior spinous process of the ilium. They send numerous ramifications to these two muscles, and the gluteus maximus;—some which mount upwards towards the crest of the ilium, to anastomose with the branches of the ilio-lumbar and circumflexus ilii arteries; and, finally, several which glide beneath the tensor vaginæ femoris muscle, and anastomose with the anterior circumflex. The middle branches descend upon the surface of the gluteus minimus towards the trochanter major: they are expended chiefly upon the glutei muscles, but like the preceding, anastomose with the anterior circumflex. Finally, the inferior, after giving branches to the gluteus minimus, perforates its fibres to reach the dorsum of the bone, where it descends in front of the acetabulum, and terminates by supplying the several muscles in the vicinity, and the capsular ligament of the

hip joint. It also anastomoses with the anterior circumflex and the ischiadic arteries.

k. *Ramus ischiadicus.* (*Fig.* 18. *m. Fig.* 20. *b.*) The ischiadic artery, though smaller than the gluteal, maintains more accurately than that vessel, the direction of the internal iliac. It arises a little below the gluteal; descends in front of the pyriform muscle, and then inclining backwards, escapes from the pelvis between the lower edge of that muscle and the anterior sacro-sciatic ligament, and in front of the sciatic nerve. In this portion of its transit, it sends small ramusculi to the pelvic organs, and to the pyriform, obturator, and levator ani muscles;—sometimes, indeed, it furnishes some of the arteries already described. Having emerged from the pelvis (*Fig.* 20. *b.*), it is covered by the gluteus maximus muscle, and immediately divides into numerous branches. One of these takes its course backwards and inwards, perforates the sacro-sciatic ligament, and after sending numerous ramifications to the gluteus maximus, reaches the coccygis, and is expended upon the levator ani, the adeps, and other adjacent structures. One or more branches descend between the trochanter major and the tuberosity of the ischium, following the course of the sciatic nerve, from which circumstance they are sometimes denominated *ramuli comes nervi ischiadici.* They descend for some distance upon the thigh, and in their course give branches to the gluteus, gemelli, quadratus femoris, semitendinosus and semimembranosus, biceps, and adductor magnus muscles; also to the nerve itself, and to the integuments. They inosculate freely with the circumflex and perforating branches of the femoral artery. The ischiadic artery, moreover, sends branches downwards upon the surface of the tuber ischii, which supply the muscles and fat in the vicinity, and anastomose with the external circumflex and the posterior branches of the obturator.

l. *Ramus pudicus internus.* (*Fig.* 18. *n. Fig.* 19. *a.*) The internal pudic artery is not quite so large as the ischiadic. It generally arises from the internal iliac a little below the origin of the vessel just mentioned—sometimes in common with it, in which case the trunk which furnishes the two branches may not divide until it has escaped from the pelvis. The artery descends at first in nearly a perpendicular direction, in front of the sacral plexus of nerves, and in company with the ischiadic artery, which is a little posterior. It glides from the pelvis below the inferior margin of the pyriform muscle, reposes for a small distance upon the posterior face of the spine of the ischium and the attachment of the anterior sacrosciatic ligament, then turns forwards through the lesser sciatic notch, between

Fig. 19.

a, Internal Pudic. *b*, Inferior Hemorrhoidal. *c*. Superficial Perineal. *d*, Transverse Perineal.

the anterior and posterior sacro-sciatic ligaments, to re-enter the pelvis, thus describing an arch the concavity of which embraces the spine of the ischium. Having made this turn, it courses along the inner surface of the tuber of the ischium, only separated from the bone by the internal obturator muscle, and is bound down by the strong obturator or perineal fascia. Thence it mounts upwards and forwards along the inner side of the ramus of the ischium and pubis, to the vicinity of the lower margin of the symphisis, where it terminates by dividing into two branches —the *ramulus corporis cavernosi penis*, and the *ramulus dorsalis penis.*

The first portion of the internal pudic artery, which is contained within the cavity of the pelvis, distributes small branches to the bladder, prostate gland, vesiculæ seminalis, and rectum,—to the vagina in the female, and to the pyriform and obturator muscles. In some cases it likewise furnishes the middle hemorrhoidal.

The second portion, which is exterior to the pelvic cavity, and posterior to the spine of the ischium, sends only a few unimportant branches to the internal obturator and gemelli muscles, and other parts in the vicinity.

The third portion is more important, on account of its liability to be wounded in the operation of lithotomy where it runs along the inner side of the tuber ischii. Besides some small branches which it sends outwards to the flexor muscles of the thigh, and inwards to the parts within

the pelvis, it distributes several of larger size to the perineum, which may be enumerated as follows:

α. *R. hæmorrhoidales inferior, s. externi.* (*Fig.* 19. *b.*) These small branches are detached from the internal pudic immediately after it has re-entered the pelvis, and while it reposes upon the inner side of the tuberosity of the ischium. They perforate the deep-seated perineal fascia, plunge through the bed of fat that fills up the deep excavation between the tuberosity of the ischium and the anus, and are chiefly expended upon the sphincter ani, and the adjacent parts of the perineum, though some of their ramifications go to the coats of the rectum, and anastomose with the middle hemorrhoidal artery.

β. *R. perinæi superficialis* (*Fig.* 19. *c.*) is larger and more regular than the preceding, immediately in front of which it takes its origin. It perforates the deep-seated perineal fascia, and takes its course forwards and inwards, in the depression between the erector penis and accelerator urinæ, sometimes above, and sometimes below the transversus perinæi muscle. In the first part of its transit, it is deep-seated, and is placed nearer the ischium than to the raphe of the perineum; but as it advances, it becomes more superficial, and inclines towards the median line. It distributes small branches to the sphincter ani, the integuments of the perineum, the transversus perinæi, the accelerator urinæ and erector penis, and to the parts in the vicinity of the ramus of the ischium and pubis. The last anastomose with branches from the femoral artery. The vessel finally reaches the posterior part of the scrotum, on which it terminates by dividing into numerous ramifications, one of which is distributed to the septum, and is denominated *r. septi scroti.*

γ. *R. transversus perinæi.* (*Fig.* 19. *d.*) This is a smaller branch than the preceding, in front of which it takes its origin from the pudic—sometimes, indeed, in common with the perineal branch. It perforates the deep-seated fascia, advances obliquely across the perineum, along the cutaneous surface of the transversus perinæi muscle, and having reached the median line, sends branches backwards to the sphincter ani, which anastomose with the external hemorrhoidal ramuli,—and others forwards, to the muscles and integuments of the perineum, which anastomose with the superficial perineal ramulus, and with the vessels of the opposite side. This branch is generally divided in making the first incision in lithotomy.

δ. *R. corporis bulbosi, s. spongiosi urethræ.* This is a considerable branch, though much shorter than either of the preceding. It arises from the internal pudic after it has reached the crus penis, and taking its course horizontally outwards, towards the bulb of the urethra, it keeps above the deep perineal fascia, and after passing a short distance, divides into two branches. One of these, of small size, descends and is expended upon Cowper's glands, while the other, much larger, plunges directly into the bulb, and ramifies throughout the whole spongy portion of the urethra as far as the glans penis, and besides, sends branches into the corpus cavernosum, and the muscles and integuments.

ε. *R. corporis cavernosi, s. profundus penis.* The ramulus of the corpus cavernosum is one of the two branches by which the internal pudic artery terminates. It comes off immediately after that vessel has perforated the triangular ligament of the urethra, and where it reposes between the bone and the crus penis. Penetrating the latter body obliquely, it ramifies most minutely through the whole extent of the corpus cavernosum, passing forwards nearly through its middle, and sending anastomosing branches across through the septum, numerous ramifications to the lining membrane of the urethra, and some which perforate the fibrous envelope of the corpus cavernosum, to supply the integuments of the penis.

η. *R. dorsalis penis* (*Fig.* 21. *o.*) glides in the space between the crus and the arch of the pubis, then perforates the suspensory ligament, and takes its course superficially along the dorsum of the penis, accompanied by its fellow and the corresponding veins. Its course is tortuous, and it forms frequent anastomoses with its companion. Near its origin, it sends ramifications to the anterior part of the scrotum and adjacent parts; and in its course it supplies the integuments of the penis, and sends some branches into the corpus cavernosum. Arrived at the prepuce, a free anastomosis is there formed between it and its fellow, and part of the ramifications are expended upon that fold of the skin, while others plunge into the glans.

In the female, the superficial perineal artery, after supplying the parts in the perineum, and the constrictor muscle of the vagina, terminates in the labia. The pudic itself, near the arch of the pubis, divides into two branches, which are distributed upon the clitoris, the one coursing

along superficially upon its dorsum (*r. dorsalis clitoridis*), the other plunging into the central portion of that body, in which it ramifies like the ramulus of the corpus cavernosum.

Varieties of the Internal Iliac Artery and its branches:

The *median sacral artery* does not properly belong to this place. But as we have described its natural distribution under the present division, we shall pursue the same course in noting its varieties. The distribution of this vessel to the kidney has been already mentioned. In addition to this anomaly, it sometimes varies in its origin. Green remarks that he has several times seen it arising from one of the lumbar arteries. In some instances it arises from the ilio-lumbar, and occasionally from the primitive iliac.

Ilio-lumbar artery. This branch arises sometimes from the primitive iliac, the femoral, or the gluteal artery. (Tiedemann.) In a few instances it takes its origin by a trunk common to it and the middle sacral; and occasionally its place is supplied by two small ramuli. (Tiedemann.) Green remarks that in one instance he observed the ascending branch of the ilio-lumbar arising from the primitive iliac.

The *lateral sacral artery* is sometimes double; and in such cases one branch generally takes its origin from the internal iliac, the other from the gluteal, ilio-lumbar, or ischiadic artery. (Hildebrandt, Tiedemann.) Occasionally there are as many as five ramuli communicating freely with each other (Green), and in a few instances it has been seen arising from the primitive iliac. (Tiedemann.)

The *gluteal artery.* The principal varieties of this artery consist in its arising in common with one or more of the vessels usually given off by the internal iliac, or in the origin of some of them from it. Thus it sometimes comes off with the ischiadic, or pudic, or middle hemorrhoidal; or it furnishes one or more of those vessels.

The *ischiadic*, *middle hemorrhoidal*, *vesical*, *uterine*, and *vaginal arteries*, vary in their origin like the gluteal; but as their anomalies present nothing peculiar, they need not be described.

Umbilical arteries. Two cases are reported by Otto (*Seltene Beobacht. und Path. Anat.*) in which the umbilical arteries of the right and left sides united within the abdomen into one trunk, which was contained within a fold of the peritoneum of about an inch in breadth. A similar case was observed by Kelch. (*Beitrage zu Path. Anat.* p. 60.) Numerous cases have been reported in which the umbilical artery on one side was entirely wanting. (Otto. *Loc. Cit.* p. 312.) Breschet observed an example in which one of these arteries took its origin from the common iliac. (*Repert. d'Anat. et Physiologie.* II. 471.); and in one instance reported by Hottenger, it arose from the aorta. (*Misc. Nat. Curios.* Dec. iii. an. 9. obs. 233.) Otto has referred to numerous authorities who have reported examples of this anomaly. (*Path. Anat.* p. 312.) Sometimes the umbilical artery arises in common with the uterine or the middle hemorrhoidal. (Tiedemann.)

Obturator artery. Anomalies of this vessel are of very frequent occurrence, and as under such circumstances the artery is often placed in the vicinity of the parts through which hernias protrude, these irregularities are important, and merit a careful consideration. It has been remarked above, that the obturator artery not unfrequently arises in common with some of the other branches of the internal iliac. Its most important varieties are those which are observed when it arises from the external iliac, the epigastric, or the femoral artery. Of these three anomalies, the origin of the obturator in common with the epigastric, is by far the most frequent. Haller observed it in nine instances. When it occurs, the trunk common to the two arteries may be from two lines to an inch and a half in length. In thirty-two bodies examined by Hesselbach, the origin of the obturator from the epigastric took place on the right side in nine, and on the left in ten. Out of 250 subjects examined by Jules Cloquet, he found the obturator arising from the epigastric on both sides in 56;—from the internal iliac on one side and the epigastric on the other in 28. The origin of this artery directly from the internal iliac is less common; yet we have several times met with it, and numerous examples have been reported by Lieutaud, Sœmmering, Burns, Monro, Cloquet, Hesselbach, Tiedemann, and others. This anomaly was observed by Cloquet in six subjects out of 250. Portal reports a case in which the obturator was formed by the union of a small branch from the internal iliac and a larger one from the epigastric (*Cours d'Anat. Médicale.* III. 332.); and three examples of a similar arrangement have been figured by Hesselbach (Tab. 3.). Occasionally the origin of the obturator artery takes place from the femoral artery below Poupart's ligament, and to

reach its point of destination it ascends along the pectineus muscle, and enters the pelvis at the crural ring. MONRO, BURNS, OTTO, TIEDEMANN, and others, have described examples of this anomaly. GREEN observed a case in which there were two obturator arteries on the left side; one from the epigastric, which was large; the other smaller, from the usual origin. They passed through the obturator ligament by distinct foramina. He also represents that there is a cast of a preparation in the museum of Dr. M'CARTNEY, in which there was no internal obturator, the muscles which that vessel supplies, receiving ramifications from an ascending branch of the profunda. The same author has figured an example in which the obturator is seen arising from the femoral artery, and as it mounts upwards, to turn over the pubis, it gives off the dorsal artery of the penis. (Tab. v. fig. 3.)

For further observations on this subject, see *Abdomen, Anat.* I. 30.

Internal pudic artery. In some instances, this vessel, instead of passing through the space between the two sacro-sciatic ligaments, descends directly behind the bladder, and through the prostate, to reach the penis; or if the artery pursues its usual course, a considerable branch may traverse the prostate gland. In either case, a fatal hemorrhage might be induced in the operation of lithotomy, as happened to Mr. SHAW, of London, a few years ago. (*Lond. Med. and Phys. Journ.*) The first of these anomalies was described by VESALIUS, and many of the older anatomists, as the natural distribution of the artery. The dorsal artery of the penis sometimes arises from the obturator artery within the pelvis. A case has been quoted above, on the authority of GREEN, in which this latter vessel proceeded from the femoral artery below POUPART'S ligament, and in its course upwards furnished the dorsal artery of the penis. It sometimes arises from the common femoral (TIEDEMANN), the superficial pudendal (*Ibid.*), or the profunda (*Ibid.*).

W. *Arteriæ iliacæ externæ.* (*Fig.* 17. *i. Fig.* 18. *d. Fig.* 21. *c.*) The division of the primitive, or common iliac arteries, at the sacro-iliac junction, has been already described. The external iliac, which is one of the great branches formed by this division, may be regarded as the proper continuation of the main iliac, and is destined to supply the whole of the inferior extremity. Like the subclavian artery, it is designated by different appellations, according to the region through which it passes. Thus, that portion of it which is included between the sacro-iliac symphisis and the lower border of POUPART'S ligament, is called external iliac artery. From the latter point to where the vessel penetrates the aponeurosis of the adductor muscles of the thigh, it is called femoral artery; while a third portion, which de-

Fig. 20.

a, Gluteal. *b*, Ischiatic. *c*, Profound Branch of Gluteal. *e*, *e*, Popliteal. *f*, External Articular. *g*, Internal Articular. *h*, Sural.

scends from this situation along the posterior face of the member, to the inferior margin of the popliteus muscle, is denominated popliteal artery. There it divides into two branches—the anterior and posterior tibial arteries, which supply the leg and foot.

The external iliac arteries of the right and left side are so similar in their distribution, that the description of one will apply to the other. From the vicinity of the sacro-iliac symphisis, at which point it separates from the internal iliac already described, the external iliac artery proceeds downwards and outwards, along the anterior internal surface of the psoas muscles, to escape from the abdomen beneath POUPART'S ligament, about midway between the symphisis pubis and the anterior superior spinous process of the ilium, but generally from a fourth to half an inch nearer the former than the latter. Having

emerged from beneath the ligament, and entered the groin, it takes the name of femoral artery, and is there so superficial, that it can be felt pulsating beneath the skin, and can be readily compressed where it glides in front of the ramus of the pubis. In its whole course, it is invested in a sheath furnished by the iliac fascia, which ties it down to the psoas muscles. In the upper portion of its transit, the corresponding vein is situated posteriorly, while in the vicinity of Poupart's ligament, and where the artery glides over the horizontal branch of the pubis, the vein is on the inner side, and on the same plane. In front, it is in relation with the peritoneum, the spermatic artery, the internal genito-crural nerve, and the iliac lymphatics which twine upon its surface. It is also crossed on this aspect by the vas deferens, as that vessel descends into the pelvis. Posteriorly, it reposes upon the inner anterior part of the psoas muscle, and where it escapes from the abdomen, it is nearly in contact with the horizontal ramus of the pubis. Externally it is in relation with the anterior crural nerve, from which it is separated above by a portion of the psoas muscle.

In its course downwards, the external iliac artery only gives a few very small and unimportant branches to the psoas muscles, glands, and adjacent parts, until it arrives near Poupart's ligament, where it sends off the following:

a. *Ramus epigastricus.* (*Fig.* 17. *l.* *Fig.* 18. *o.* *Fig.* 21. *e.*) The *epigastric artery*, which is of considerable size, is destined to supply the anterior wall of the abdomen. It generally arises from the anterior internal part of the external iliac, about a quarter or half an inch above Poupart's ligament, though in some instances it is detached from that vessel higher up or lower down; and occasionally it arises from the femoral artery. At its origin, it is placed between the fascia transversalis and peritoneum, a little below the point at which the latter membrane is reflected backwards upon the iliac fossa. When it arises higher than usual, it sweeps downwards towards Poupart's ligament—then upwards and inwards, forming a curve having its convexity downwards. But when it proceeds from its natural point of origin, it advances at once upwards and inwards, behind the aponeurosis of the internal oblique and transversalis muscles, and between the fascia transversalis and peritoneum. It thus ascends in an oblique direction, towards a point situated nearly midway between the umbilicus and the pubis, glides behind the rectus muscle, the sheath of which it perforates upon its posterior part, and then divides into numerous ramifications which branch out extensively in that muscle and the neighbouring parts, and anastomose freely with the internal mammary, and the inferior intercostal arteries.

When the epigastric artery first commences its ascent, it ranges along the inner boundary of the internal abdominal ring, immediately behind the vas deferens and the spermatic artery and veins, which cross it in an oblique direction; and as the vas deferens separates at this point from the other vessels of the chord, and inclines downwards and inwards to descend into the pelvis, it is hooked around the epigastric artery on its external, or iliac aspect, where it crosses that vessel. Besides the spermatic vessels, the artery has the fascia transversalis and the aponeurosis of the abdominal muscles in front: behind, it is in relation with the peritoneum, —and upon its pubic side, it is accompanied by the epigastric vein; and sometimes it has a second vein on its outer side.

In this course, the epigastric sometimes gives origin to the obturator artery;—it always furnishes several branches of smaller size to the neighbouring parts. Near the internal abdominal ring, it detaches a small branch, which descends upon the spermatic chord, escapes with it through the external abdominal ring, and supplies the cremaster muscle and the tunica vaginalis, and anastomoses with the spermatic artery. Near the same point, it sends a small branch inwards, which follows the horizontal branch of the pubis, passes behind the abdominal ring, and anastomoses, near the symphisis pubis, with its fellow of the opposite side. The epigastric artery, besides, gives off numerous branches of small size from its external and internal sides, which are distributed to the abdominal muscles; and also some which perforate the aponeurosis to be expended upon the integuments. It is chiefly through the free anastomosis between the terminal ramifications of this artery, and those of the internal mammary and the intercostals, that the circulation is maintained, when the aorta or the iliac artery becomes obliterated.

b. *Ramus circumflexus ilii.* The *circumflexus ilii artery* (*Fig.* 17. *k.* *Fig.* 18. *p.* *Fig.* 21. *d.*) is smaller than the epigastric. It arises from the outer side of the external iliac, on a level with Poupart's ligament, or a few lines above that point: in some instances it has a common origin

with the epigastric. Included in a sheath furnished by the splitting of the iliac fascia, where that aponeurosis is about to be reflected forward to become continuous with the fascia transversalis, the artery advances outwards towards the anterior superior spinous process of the ilium, in front of the crural nerve, and the psoas and iliacus internus muscle. In its course, it sends small branches to these muscles and to the cellular tissue of the iliac fossa, —also, several which pass downwards behind POUPART's ligament to the upper part of the thigh, where they anastomose with the superficial external circumflex branch of the femoral artery. Near the spine of the ilium, the circumflex artery divides into an external and an internal branch. The first glides between the transversalis and internal oblique muscles, and is expended upon the walls of the abdomen. The second follows the inner labium of the crest of the ilium, sending branches outwards to anastomose with the ascending ramuli of the gluteal artery. Having pursued this course for some distance, it distributes numerous ramuli to the broad abdominal muscles, and terminates posteriorly by anastomosing freely with the ilio-lumbar, inferior lumbar, lower intercostal, and the internal mammary arteries.

Varieties of the external iliac artery and its branches:

Epigastric artery. The frequent origin of this vessel in common with the obturator, has been already noticed. It may take place either above or below POUPART's ligament. In one case of this kind observed by TIEDEMANN, the circumflexus ilii took its origin from the femoral artery, below the ligament just mentioned, and furnished a considerable branch to the thigh. The origin of the epigastric singly from the external iliac, higher or lower than usual, is not uncommon; and several cases have been observed, in which it came off from the femoral artery in the groin. This anomaly we have witnessed in three or four instances. BURNS also observed it, and it occurred to HESSELBACH in three subjects. TIEDEMANN likewise observed two examples. The origin of the epigastric from the profunda femoris is rarely observed; yet a case has been figured by TIEDEMANN, and a similar one was noticed by MONRO. GREEN also remarks, that in a body which was dissected at Trinity College, Dublin, the profunda was given off above POUPART's ligament, and produced the epigastric within the abdomen. A case is reported by MONRO, in which this vessel took its origin from the obturator, and passed directly upwards and inwards to the rectus muscle. The same author remarks, that it sometimes arises from the pudic artery. (*Morbid Anat. of the Stomach and Gullet.* p. 123.) In some instances the epigastric artery ascends along the course of the linea alba, below the umbilicus; and a case has been reported to us, in which, under this anomalous distribution, the vessel was wounded by the trocar in the operation of tapping, and occasioned fatal hemorrhage. Sometimes there is an accessory epigastric artery of small size, which ascends along the outer edge of the internal abdominal ring, to be expended upon the walls of the abdomen. (MECKEL, HILDEBRANDT.)

Circumflexus ilii. This artery not unfrequently arises from the femoral artery below POUPART's ligament, in which case it sends ramuli to the upper part of the thigh. It sometimes takes its origin in common with the epigastric artery;—and MONRO witnessed a case, in which it sent a branch nearly as large as the epigastric, under POUPART's ligament, about two inches from the symphisis pubis, which distributed numerous ramifications upon that articulation, and the fat and skin over the crural arch. (*Loc. Cit.* p. 126.)

X. *Arteria femoralis, s. cruralis.* (*Fig.* 21. *m, m.*) The external iliac artery, it has been already remarked, takes the name of femoral, or crural artery, as soon as it emerges from beneath POUPART's ligament and enters the groin. It is here situated superficially in the middle of a triangular space, the base of which is formed by POUPART's ligament, the internal limb by the pectineus and adductor longus muscles, and the external by the sartorius. From this point it winds downwards along the anterior and internal part of the thigh, in a spiral direction, following a deep furrow or depression, which is bounded internally by the adductor muscles, and externally by the vastus internus, until it reaches the junction of the middle with the inferior third of the thigh. It then engages itself in a strong aponeurotic sheath formed by the tendons of the adductor longus and adductor magnus, which it traverses to reach the posterior face of the member, when it continues to descend under the name of popliteal artery. Thus the femoral artery, after reposing above upon the horizontal branch of the pubis, and in front of the head of the femur, from which it is only separated by the psoas muscle, twines around the

internal face of the bone in a spiral direction, until it passes from the anterior to the posterior face of the limb. In the upper part of the thigh, it is only covered by the skin, superficial fascia, a stratum of lymphatic glands, and by the fascia lata. Here, therefore, it can be most conveniently exposed when it becomes ne-

Fig. 21.

a, Bifurcation of Common Iliacs. *b*, Middle Sacral. *c*, External Iliac. *d*, Circumflexus Ilii. *e*, Epigastric. *f*, Superficial Pudendal. *g*, Division of Common Femoral. *h*, Superficial Muscular. *i*, External Circumflex. *k*, Superficial Epigastric. *l*, Profunda. *m*, Femoral. *n*, Internal Circumflex. *o*, Dorsalis Penis. *p*. Anastomoticus Magnus.

cessary to include it in a ligature. In the middle third of the thigh it is deeper seated, because the sartorious muscle, in winding down the anterior internal part of the member, advances in front and overlaps the artery as low as the point at which it perforates the tendons of the adductors. Internally, the femoral artery is in relation, above, with the pectineus muscle, and lower down, with the adductor longus. Where it enters the groin, the femoral vein is also on the pubic aspect of the artery, but as it descends, the vein gradually gets upon its posterior face. Externally, it is in relation, at first with the psoas muscle and the anterior crural nerve, which is slightly separated from it; and afterwards with the vastus internus. In its whole extent, it is invested by a strong sheath common to it and the vein; and throughout the middle third of the thigh, the anterior saphena nerve courses along its anterior external face. Posteriorly, the artery reposes at first upon a round prominence occasioned by the head of the femur and the psoas muscle; but as it descends, it ranges along in front of the tendinous attachments of the adductor muscles to the bone, and parallel with the inner margin of the vastus internus.

The branches furnished by the femoral artery may be divided into superficial and deep-seated.

a. *Ramus epigastricus superficialis.* (*Fig.* 21. *k.*) This is a small superficial branch which is expended upon the anterior wall of the abdomen. It arises from the anterior part of the femoral artery about half an inch below Poupart's ligament, and is reflected directly upwards and inwards, in front of that band and the aponeurosis of the abdomen. It gives small ramuli to the inguinal glands and adjacent parts, then ascends beneath the skin in the direction of the umbilicus, in the vicinity of which, after supplying numerous small ramuli to the integuments of the abdomen, which anastomose with those of the deep-seated epigastric, it forms a free anastomosis with the internal mammary.

b. *Ramus pudicus superficialis.* (*Fig.* 21. *f, f.*) There are generally two superficial pudendal arteries, which nevertheless often have a common origin. One is superficial,—the other deep-seated.

The first generally arises from the internal part of the femoral artery, a little below Poupart's ligament. It proceeds directly inwards between the skin and the fascia lata, giving small ramuli to the inguinal glands, and near the spine of the pubis, sends branches upwards to the integuments of the lower part of the abdomen and the mons veneris, while others are distributed to the scrotum and root of the penis in the male, and to the labia in the female.

The profound branch arises somewhat lower than the preceding, and sometimes comes off from the internal circumflex. It advances directly inwards, in front of the pectineus muscle, and beneath the fascia lata—finally perforates the latter, and expends itself by numerous ramifications upon the scrotum and the perineum, where it anastomoses with the superficial perineal artery. In the female, it sends branches to the labia major.

c. *Ramus muscularis superficialis, s. circumflexus ilii superficialis* (*Fig.* 21. *h.*) is a small branch which arises from the outer side of the femoral artery, nearly opposite the branch last described. It

ranges outwards below Poupart's ligament and parallel with it, and near the anterior superior spinous process of the ilium divides into several ramuli, which supply the sartorius, tensor vaginæ femoris, rectus, and iliacus internus muscles, and anastomose with the branches of the external circumflex, the circumflexus ilii profundus, and the gluteal. It also sends minute ramuli to the inguinal glands, and to the integuments.

d. *Ramus femoralis, s. cruralis profundus.* (*Fig.* 21. *l.*) If, instead of describing the arteria profunda as a branch of the femoral, we were to follow Murray, Barclay, and others, who described the main trunk of the crural artery, before it divides, under the denomination of cruralis communis, and the two great vessels formed by its division, under the appellations of superficial and profound femoral arteries, the description would harmonize better with the natural arrangement of those vessels. The arteria profunda, indeed, nearly equals the femoral proper in size, and differs from it chiefly in its deeper situation, its destination being the profound parts of the thigh, while the femoral is placed superficially, and is appropriated, for the most part, to the leg and foot.

In a majority of instances the profound femoral artery arises from the posterior part of the crural, about an inch and a half or two inches below Poupart's ligament, or about midway between the pubis and the level of the trochanter minor. Sometimes, nevertheless, it is given off below this point, sometimes above it, and occasionally even from the external iliac itself. It advances downwards and backwards, at first forming a slight curve with its convexity towards the sartorius muscle, but afterwards inclines inwards as it descends. At its origin, it reposes upon the lower part of the psoas and iliacus muscles, but as it proceeds downwards and backwards, it ranges in front of the tendon of the pectineus and adductor brevis near their attachment to the linea aspera of the femur. Finally, near the junction of the upper with the middle third of the thigh, it perforates the space between the adductor brevis and the adductor longus—sometimes the tendon of the latter muscle, and after traversing the adductor magnus, and supplying it with several branches, it terminates by numerous ramifications in the flexor muscles situated upon the posterior part of the thigh. In its whole course, in short, it twines round the inner part of the femur, precisely as the superior collateral of the arm twines round the surface of the humerus.

In the first part of its transit, the profound femoral artery is merely covered by the integuments, inguinal glands, fascia lata, and cellular tissue; but lower down, the superficial femoral artery and vein are in front of it; while posteriorly, it reposes upon the tendons of the pectineus and adductor brevis muscles, and is placed in the vicinity of the bone. It furnishes the following branches:

α. *R. circumflexus externus.* (*Fig.* 21. *i, i.*) The *external circumflex artery* is a very stout branch at its origin, but soon loses its volume by dividing into numerous ramuli. It arises from the outer part of the profunda near the point at which that artery separates from the superficial femoral, and sometimes from the common crural. Proceeding directly outwards in a transverse direction, it runs in front of the psoas, iliacus internus, and crureus muscles, and behind the sartorius and rectus femoris. After detaching a small branch backwards, in the vicinity of the trochanter minor, which anastomoses with the internal circumflex, and some small unimportant muscular ramuli, it divides into ascending and descending branches.

The *ascending branches* are variable in number. Most of them proceed directly backwards and upwards, behind the tensor vaginæ femoris, and between that muscle and the anterior part of the gluteus medius and gluteus minimus. They are expended by numerous ramusculi upon these muscles and the capsule of the hip joint, and anastomose freely with the anterior ramifications of the gluteal, circumflexus ilii, and internal circumflex arteries. One or two of them incline directly outwards and backwards; perforate the upper part of the vastus internus, and twine round the outer surface of the femur below the trochanter major, to terminate in the gluteus maximus, and anastomose with the internal circumflex, gluteal, and ischiatic arteries.

The *descending branches* take their course downwards upon the anterior external part of the thigh, between the vastus externus, crureus, and rectus muscles, to the outer part of the knee joint, where they anastomose with the articular branches of the popliteal artery. These descending ramuli supply the integuments, the tensor vaginæ femoris, vastus externus, crureus, and rectus muscles, and anastomose with the perforating ramuli of the profunda.

β. The *internal circumflex artery* (*r. circumflexus internus*) (*Fig.* 21. *n.*) is larger than the preceding, and is much deeper seated in the whole of its course and distribution. It usually arises from the posterior internal part of the profunda, near the separation of that vessel from the superficial femoral—sometimes from the latter vessel itself. It winds directly backwards, around the inner part of the neck of the femur, above the trochanter minor, and in the space between the psoas and iliacus, and the pectineus muscles. It is here embedded in a mass of cellular tissue, and near the head of the bone, transmits a small branch (*r. acetabuli*) to the acetabulum, which enters its cavity beneath the ligament closing the notch, and then following the ligamentum teres, expends its minute ramusculi within the joint. The circumflex artery advances in front of the obturator externus muscle, and divides into a superior and an inferior branch. The first follows the course of that muscle to its attachment in the digital cavity of the trochanter major, where it terminates by numerous ramusculi, which twine about the neck of the bone, and anastomose with the branches of the external circumflex and the gluteal arteries. In its course, this branch distributes numerous ramusculi to the obturator externus muscle, which anastomose with those of the obturator artery; others to the pectineus, gracilis, and the adductors, and some which traverse these muscles to reach the perineum. The inferior branch advances directly outwards, between the quadratus femoris and adductor magnus, sends ramusculi to both these muscles, and to the semitendinosus and semimembranosus in the vicinity of the tuber ischii. It also distributes some to the posterior part of the thigh, which follow the course of the sciatic nerve, the gluteus maximus, and the posterior part of the vastus externus. Near the trochanter major, and the posterior part of the neck of the bone, it forms a very free anastomosis with the external circumflex, gluteal, ischiatic, and superior perforating arteries.

The free anastomosis of the two circumflex arteries, with the obturator, pudic, gluteal, and ischiatic branches of the iliac arteries above, and with the perforating ramuli of the profunda below, furnishes a collateral circulation sufficiently capacious to compensate for the obliteration of either the external iliac, or the common femoral artery, when it becomes necessary to secure them in a ligature.

After the profunda has furnished the two circumflex branches, and while it is coursing along the anterior face of the tendons of the adductor muscles, it generally furnishes from one to four or five branches, which pass directly backwards to the posterior part of the thigh, and are denominated perforating arteries. Three branches of this kind are generally described.

γ. The *superior perforating artery* (*r. perforans superior, s. primus*) arises from the posterior part of the profunda, a little below the trochanter minor—sometimes from the internal circumflex. It passes directly backwards through the aponeurotic attachment of the adductor brevis, or in the space between the tendon of that muscle and the pectineus, sending branches to both; then perforates the adductor magnus, and divides into numerous ramusculi which are distributed to that muscle, to the gluteus maximus, biceps, semitendinosus and semimembranosus. Above, it anastomoses with the obturator, internal circumflex, gluteal, and ischiatic arteries;—below, with the middle and inferior perforating ramuli.

δ. *R. perforans medius, s. secundus.* The *middle perforating artery* arises from the profunda a little below the preceding, and like it perforates the aponeurotic attachment of the adductor brevis. It then plunges into the adductor magnus, and supplies it and the other adductors with numerous ramusculi. Having reached the posterior part of the thigh, it distributes numerous ramifications to the flexor muscles, the gluteus maximus, and vastus externus. While passing in the vicinity of the femur, it generally sends a small nutritious branch upwards, which penetrates the shaft of the bone in an oblique direction, and ramifies upon the medullary membrane. The middle perforating branch inosculates with the same arteries as the superior.

ε. *R. perforans inferior, s. tertius.* The *inferior perforating artery* is much smaller than either of the two branches described above. It arises from the profunda on a level with the tendon of the adductor longus, and after traversing the aponeurosis of the adductor magnus, is distributed to the long flexors of the thigh, after the same manner as the superior and middle perforating arteries, with which it anastomoses above, while below it inosculates freely with the articular branches of the popliteal artery.

Besides these branches, the profound

femoral artery furnishes others of small size, to the psoas, iliacus internus, pectineus, vastus internus, and all the adductor muscles of the thigh.

The superficial femoral artery, while it courses down the thigh, gives numerous small branches to the vastus internus, sartorius, and adductor muscles; but they are unimportant, and do not require a particular description. Near its termination in the popliteal artery, and where it becomes engaged in the aponeurosis of the adductor muscles, it gives origin to the following branch, which is of larger size:

e. *R. anastomoticus magnus.* (*Fig.* 21. *p.*) This branch is detached from the femoral where it enters the aponeurotic sheath formed for that vessel by the tendon of the adductor muscles and the fascia of the vastus internus. It immediately perforates the fascia, and descends in company with the saphena nerve towards the inner part of the knee, where it divides into numerous ramuli, which anastomose with the articular branches of the popliteal, and the recurrent branch of the tibial artery. It likewise sends branches outwards, behind the tendon of the rectus, which anastomose with the descending ramuli of the external circumflex.

Varieties of the femoral artery and its branches:

Common femoral artery. The point at which this vessel divides into the superficial femoral and the profunda, is subject to considerable variety, and has been differently represented. The average will probably be found to be, from one and a half, to two inches below Poupart's ligament. Bell has described it as taking place four inches below that point; but when this arrangement exists, it should be regarded as an anomaly. Haller, in one case, saw the division taking place where the artery is about to glide beneath the sartorius muscle. Cases in which the artery divides higher than usual, in the immediate vicinity of Poupart's ligament, are not uncommon. (Otto. *Path. Anat.* p. 313.) In some instances, indeed, the bifurcation takes place within the abdomen, presenting an analogy with the high division of the brachial artery. This is said by Tiedemann to occur oftener in females than in males, and in individuals of short stature, than in such as are tall. Burns observed four examples of this anomaly; Otto two; and Tiedemann one. In each of the cases witnessed by Otto, the high division existed on both sides. This variety is important in relation to operations performed upon these vessels.

The *circumflex arteries* vary considerably in their origin. Not unfrequently one or both of them take their origin from the common femoral—occasionally from the superficial femoral: and in one instance observed by Burns, the internal circumflex proceeded from the external iliac, and descended through the crural ring to its point of destination. In two cases delineated by Green, the profunda femoris wound round in front of the femoral vein, before it made its descent to become deep-seated; and in one of these instances, this vessel furnished the epigastric artery. Otto refers to an example in the collection of the University of Breslau, in which the femoral vein is perforated by a branch, from the profunda.

Superficial femoral artery. The most remarkable anomaly of this vessel, is that in which it divides a little below the origin of the profunda into two branches, which run parallel with each other through the thigh, and again unite in the tendinous sheath of the triceps. An example of this kind was observed by Sir C. Bell, in an individual on whom an operation for aneurism had been performed (*Lond. Med. and Phys. Journ.* August, 1826.), and a second has been reported by Houston (*Dublin Hospital Reports.* IV. 314.). Sometimes the femoral artery divides into the posterior tibial and the peroneal artery, high in the groin. Sandifort reports an example in which this bifurcation took place directly beneath Poupart's ligament (*Obs. Anat. Path.* Lib. iv. 97.); Portal met with it in the middle of the thigh (*Cours d'Anat. Méd.* III. 239.); and Zagorskey observed a branch running parallel with the femoral artery, which terminated below at the internal malleolus (*Mem. de Petersb.* 1803–6.).

Y. *Popliteal artery.* (*Arteria poplitæa.*) (*Fig.* 20. *e, e.* *Fig.* 22, *a.*) The femoral artery, having reached the posterior face of the femur by perforating the aponeurotic sheath formed by the tendon of the adductor and vastus internus muscles, then takes the name of popliteal artery. From this point to where it terminates on a level with the lower margin of the popliteal muscle, it descends in nearly a perpendicular direction, along the posterior face of the limb, inclining, nevertheless, a little outwards. In the first part of its transit, it is placed nearly midway between the semitendinosus and semimembranosus, which form the inner boundary of the popliteal space, and the biceps, which limits this region externally;—then along the posterior face of the knee joint,

between the two condyles of the femur; and finally in the space between the two heads of the gastrocnemius externus. Having arrived on a level with the lower edge of the popliteus muscle, it divides into the anterior and posterior tibial arteries. It reposes at first anteriorly, against the posterior face of the femur, from which it is slightly separated by cellular tissue and adipose substance; then upon the posterior face of the knee joint; and finally on the same face of the popliteus muscle. At its commencement, it is covered to a small extent, by the semimembranosus muscle; but in the popliteal space it is deep-seated, and is embedded in a mass of adeps, which fills up the interval between the hamstrings, and is interposed between the artery and the aponeurosis and skin. The popliteal vein and nerve also occupy its posterior aspect, the first being in contact with the artery,—the second more superficial, but both inclined slightly towards its fibular side. Below the condyles of the femur, it is covered by the gastrocnemius muscle, and near its termination, by an aponeurotic band furnished by the upper edge of the soleus. A little above the knee joint there are likewise two or three small lymphatic glands which repose in immediate contact with the vessel.

Fig. 22.

a, Popliteal. *b*, Superior External Articular. *c*, Superior Internal Articular. *d*, Sural.

The popliteal artery furnishes several small unimportant branches to the muscles and adjacent parts; but besides these, it gives off five of larger size, which deserve a particular description.

a. *R. articularis superior externus.* (*Fig.* 20. *f. Fig.* 22. *b. Fig.* 24. *b.*) The *superior external articular artery* takes its origin from the outer part of the popliteal, immediately above the external condyle. Reposing close upon the bone, it turns directly outwards—then forwards, beneath the tendon of the biceps muscle, and after sending branches to it, divides into two ramuli. The first inclines a little upwards, and is expended upon the lower part of the extensor muscles, where it inosculates with the descending ramuli of the external circumflex. The other winds round the condyle to reach the patella, traversing in its course the lower part of the vastus externus muscle, which, as well as the joint, and the head of the femur, receive from it numerous ramusculi. It finally ramifies extensively upon the surface of the patella, and inosculates freely with the other articular, and the recurrent branches.

b. *R. articularis superior internus.* (*Fig.* 20. *g. Fig.* 22. *c. Fig.* 24. *c.*) The place of this ramus is sometimes supplied by several branches which arise irregularly from the popliteal artery. When the superior internal articular artery is single, it generally springs from the popliteal a little above the condyle of the femur, though sometimes it comes off near the point at which that artery perforates the aponeurosis of the adductor muscles. Passing inwards, it winds round the posterior internal part of the bone above the internal condyle, glides beneath the tendons of the semitendinosus and semimembranosus—then beneath that of the adductor magnus, and divides into several ramuli. Some of these plunge into the vastus internus, and anastomose with the external circumflex, and the superior external articular. Others descend along the tendon of the adductor magnus to the internal part of the knee, to the structures of which they distribute numerous small ramusculi. These, as well as others which ramify upon the surface of the patella, inosculate with the anastomoticus magnus, and the inferior internal articular.

c. *R. articularis medius superior.* The *superior middle articular artery* is smaller than the preceding. It arises from the anterior part of the popliteal artery, or from the external articular, and descending between the two condyles, distributes ramuli to the ligaments upon the posterior part of the joint, to the adeps, and the head of the bone. One or more small branches also penetrate the cavity of the joint, to supply the synovial membrane and the crucial ligaments.

Having descended below the level of the condyles of the femur, the popliteal artery furnishes the following branches:

d. *R. surales, s. musculares.* (*Fig.* 20. *h. Fig.* 22. *d.*) There are generally two *Sural arteries* which arise from the posterior part of the popliteal at an acute angle. Each one descends

towards the posterior face of the corresponding head of the gastrocnemius externus, and both of them plunge into the substance of that muscle, in which they ramify as low as the point at which its fleshy belly terminates in the tendon common to it and the soleus.

e. *R. articularis inferior externus.* The *inferior external articular artery* (*Fig.* 24. *d.*) arises from the outer side of the popliteal artery below the external condyle. It turns outwards, beneath the outer head of the gastrocnemius externus and the upper part of the plantaris — then glides beneath the tendon of the biceps and the external lateral ligament, and divides into two branches. One of them ramifies upon the head of the tibia, and anastomoses with the recurrent: the other runs along the outer margin of the semilunar cartilage, and after sending ramuli to the structures of the joint, mounts upon the patella, and inosculates with the other articular arteries.

f. *R. articularis inferior internus.* The *inferior internal articular artery* (*Fig.* 24. *e.*) arises from the inner part of the popliteal artery below the internal condyle. It turns downwards and inwards, beneath the internal attachment of the gastrocnemius muscle, winds round the inner part of the head of the tibia, and glides between it and the tendons of the sartorius, gracilis, and semitendinosus. Having sent small ramusculi to the parts in the vicinity, it ascends upon the anterior internal part of the knee, and inosculates with the superior articular arteries, and the anastomoticus magnus. It sends numerous ramusculi to the head of the tibia, and the structures of the joint.

Besides these branches, the popliteal sends some, of small size, to the gastrocnemius and popliteus muscles; but having reached the inferior border of the latter, and become engaged beneath an aponeurosis pertaining to the attachment of the soleus, it divides into the anterior and posterior tibial arteries, both of which are expended upon the leg and foot.

R. tibialis anticus. The *anterior tibial artery* (*Fig.* 23. *a, a.*) extends from the termination of the popliteal, down the anterior part of the leg to the ankle joint, and thence upon the dorsum of the instep, as far as the space between the base of the first and second metatarsal bones—the latter portion of it being denominated *arteria dorsalis pedis*. Though smaller than the posterior tibial artery, it is a vessel of considerable size. From its origin, it proceeds at first almost horizontally forward, between the heads of the tibia and fibula, and over the upper margin of the interosseous ligament, upon which it glides to reach the anterior part of the leg. Having advanced thus far, it turns directly downwards over the edge of the ligament, and descends upon its anterior face, placed at first between the tibialis anticus and the extensor communis digitorum, afterwards between the first of these muscles, and the extensor longus pollicis. It gradually inclines towards the tibia as it descends, upon the surface of which it reposes near the ankle joint; glides beneath the anterior tarsal ligament, and then continues its course forwards upon the dorsum of the instep, under the name of *arteria dorsalis pedis.* (*Fig.* 23. *d.*)

Fig. 23.

a, Anterior Tibial. *b*, External Malleolar. *c*, Tarsal. *d*, Dorsalis Pedis. *e*, Recurrent. *f*, Internal Malleolar. *g*, Metatarsal. *h*, Dorsalis Pollicis.

In the upper two thirds of the leg, the anterior tibial artery is deep-seated, and reposes upon the anterior face of the interosseous ligament, having the tibialis anticus muscle on one side, and the extensor communis digitorum on the other. In the inferior third it is more superficial, reposes throughout a part of its transit on the tibia, and is placed between the tibialis anticus and the extensor longus pollicis. But as the tendon of the latter muscle inclines inwards to reach the great toe, it crosses the artery obliquely near the ankle joint, to become placed beyond that point on its tibial side. The artery is besides accompanied in its whole course with two corresponding veins, between which it is placed. It is also in relation with the anterior tibial nerve, which is on its fibular side above, in front about the middle of the leg, and again on the fibular side below.

While the artery is passing forwards through the interosseous space, between the two heads of the tibialis posticus, it detaches small branches to that muscle, and the flexor communis digitorum. But the first important branch furnished by it is

a. The *recurrent artery* (*r. recurrens*). (*Fig.* 23. *e.*) This branch arises from the anterior tibial artery where it passes through the interosseous space. Then turning directly upwards it passes through the upper part of the tibialis anticus, to which it gives numerous ramuli, then perforates the aponeurosis of the leg, and branches out extensively upon the anterior and lateral part of the knee. It gives ramuli to the parts about the joint, and inosculates freely with the articular and great anastomotic branches. It is by these anastomoses, that the circulation of the lower extremity is maintained, when the popliteal artery has been obliterated by a ligature.

In the whole of its course down the leg, the anterior tibial artery furnishes many small branches on each side to the muscles placed in its vicinity, and a little above the ankle, it gives off the internal and external malleolar branches.

b. *R. malleolus internus. Internal malleolar artery.* (*Fig.* 23. *f.*) This branch arises from the anterior tibial artery about two inches above the ankle joint. It passes directly inwards between the bone and the tendon of the tibialis anticus, descends upon the internal malleolus, and divides there into numerous ramusculi, some of which are expended upon the joint, while others anastomose with the ramifications of the posterior tibial artery.

c. *R. malleolus externus.* The *external malleolar artery* (*Fig.* 23. *b.*) is generally a little larger than the preceding, and arises nearly opposite to it. Advancing downwards and outwards, behind the tendons of the common flexor of the toes and the peronæus tertius, and in front of the ankle joint, it anastomoses with the anterior peroneal ramulus which comes through the interosseous ligament, sends small branches to the ankle joint and the adjacent portion of the tibia and fibula, and finally descends along the external malleolus to the outer part of the dorsum of the instep, where it anastomoses freely with the posterior peroneal, tarsal, and external plantar branches.

A. dorsalis pedis. Dorsal artery of the foot. (*Fig.* 23. *d.*) It has been already remarked, that when the anterior tibial artery advances upon the instep, after having passed beneath the anterior tarsal ligament, it takes the name of dorsal artery of the foot. This vessel advances forwards and a little inwards, from the ankle joint to the posterior extremity of the first and second metatarsal bones, between which it passes down in a vertical direction, to reach the sole of the foot. In this course, it is covered by the short extensor of the toes, and the aponeurosis and integuments of the instep. It is crossed obliquely in the first part of its course by one of the tendons of the long common extensor; but beyond that point, is placed between the tendon of the common extensor and that of the great toe, and reposes upon the surface of the astragalus and the naviculare. In its direction, it departs indeed but little from that of the anterior tibial artery, with which it is continuous; and should it be necessary to ascertain the whole course of that vessel with more accuracy, it will be represented by a line drawn from the inner part of the head of the fibula, to the central point between the base of the first and the second toe.

Besides several small ramuli given off by the dorsal artery of the foot to the adjacent structures, it furnishes some which merit a particular description.

a. *R. tarsalis.* (*Fig.* 23. *c.*) The *tarsal artery* is not always a separate branch, but sometimes arises in common with the next. It generally comes off from the dorsal artery of the foot, on a level with the articulation of the astragalus with the naviculare, and advances forwards and outwards across the dorsum of the tarsus, and beneath the fleshy portion of the short common extensor of the toes. It furnishes ramuli to that muscle and to the articulations of the tarsal bones, and having arrived at the external part of the foot, turns downwards beneath the tendon of the peronæus brevis, distributes ramuli to the abductor minimi digiti, and anastomoses with the external plantar, the peroneal, and external malleolar arteries.

b. *R. metatarsalis.* The *metatarsal artery* (*Fig.* 23. *g.*) is smaller than the last, and takes its origin from the dorsal artery of the foot a little further forwards. It advances outwards and a little forwards, beneath the short common extensor, and across the base of the metatarsal bones. In its course, it often forms a slight curve, the convex surface of which is directed forwards; and besides branches to the tarsus, the articulations of the tarsal with the metatarsal bones, and the outer part of the foot, it gives off three of larger size from its convex surface, which advance directly forwards along the three outer interosseous spaces, to the cleft of the toes. These are denominated *interosseal* branches, because they supply the inter-

osseii muscles. Each one of them anastomoses posteriorly and anteriorly with the perforating ramuli of the plantar arteries, and at the anterior extremity of the metatarsal bone divides into an internal and an external ramusculus, destined for the corresponding side of each toe. The most external of these small branches also furnishes a ramusculus to the outer side of the little toe, and anastomoses with the external plantar artery.

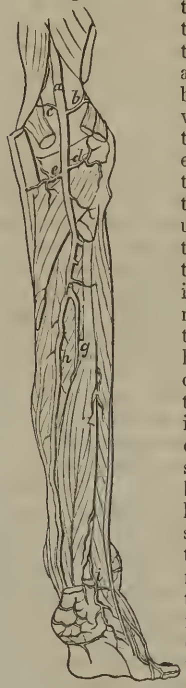
Where the dorsal artery of the foot is about to turn downwards between the metatarsal bone, it gives rise to

c. *R. dorsalis pollicis.* The *dorsal artery of the great toe* (*Fig.* 23. *h.*) marches superficially upon the fibular side of the first metatarsal bone to its articulation with the first phalanx. There it divides into two branches, one of which is appropriated to the outer side of the great toe, —the other to the inner side of the toe next to it. In its general arrangement, it represents the type of one of the interosseal arteries.

d. *R. communicans.* The *communicating artery* is properly the termination of the dorsal artery of the foot, or rather of the anterior tibial artery. That vessel having reached the posterior part of the interosseous space, between the first and second metatarsal bones, there makes a sudden turn downwards towards the sole of the foot, between the two bones, and having reached that region, divides into an external and an anterior branch. The first passes outwards for a small distance between the lower surface of the metatarsal bones and the accessory flexor, where it anastomoses with the external plantar artery, to complete the arch formed by that vessel; the other advances forwards along the outer border of the first metatarsal bone, sending ramuli to its short flexor and abductor muscles, and near the great toe, divides into two branches, one of which supplies the outer border of that member, while the other is appropriated to the inner border of the toe next to it.

R. tibialis posticus. The *posterior tibial artery* (*Fig.* 24. *h*, *h.*), which from its size and direction may be regarded as the continuation of the popliteal artery, descends along the posterior face of the leg, between the superficial and deep-seated strata of muscles, from the lower edge of the popliteus to the fossa between the os calcis and the internal malleolus, where it glides beneath the retinacular ligament of the ankle joint, and the abductor pollicis, and divides into the internal and external plantar arteries. It is somewhat tortuous, and its course is a little oblique from without inward, corresponding to a line extended from the middle of the popliteal space to the posterior part of the internal malleolus. In the upper two thirds of the leg, the posterior tibial artery is covered by the gastrocnemius and soleus muscles; but in the lower third, it runs along the inner margin of the tendo-Achilles, and is only covered by the aponeurosis which extends from that tendon to the edge of the tibia. In the first part of its transit, it reposes upon the posterior tibial muscle; but in the middle of the leg, it runs upon the common flexor of the toes, and is about half an inch from the outer edge of the tibia. Finally, in the inferior third of its course, it is only separated from the bone by a little cellular and adipose tissue; and where it turns beneath the malleolus to pass into the sole of the foot, it reposes upon the concave surface of the calcis. In its whole transit, it is placed between the two corresponding veins, and the posterior tibial nerve which is situated on its inner side above, but crosses over the artery as it descends, to occupy its fibular side. Where it descends behind the internal malleolus, it has the tendons of the tibialis posticus and flexor communis invested in their aponeurotic sheath, between it and that prominence, and on its posterior part, the tendon of the flexor longus pollicis.

Fig. 24.



a, Popliteal. *b*, Superior External Articular. *c*, Superior Internal Articular. *d*, Inferior External Articular. *e*, Inferior Internal Articular. *f*, Division of Posterior Tibial and Fibular Artery. *g*, Peroneal. *h*, Posterior Tibial. *i*, Posterior Peroneal Branch.

Near its origin, the posterior tibial artery furnishes several muscular branches to the popliteus, gastrocnemius, soleus, tibialis posticus, and flexor communis digitorum. But the only one deserving a particular description is the following:—

a. *R. peronæus.* The *peroneal*, or *fibular artery* (*Fig.* 24. *g.*), which varies much in size, generally arises from the outer part of the posterior tibial artery, about an inch, or an inch and a half, below the separation of that vessel from the popliteal, and passes thence in an oblique direction downwards and slightly outwards, towards the inferior part of the fibula. In its course, the artery passes first through a portion of the fibres of the tibialis posticus, to reach the inner side of the fibula. It then courses along that bone, in front of the interosseous ligament, and is overlapped by the flexor longus pollicis. About two inches above the external malleolus it divides into two terminal branches, one of which is posterior,—the other anterior. In the upper portion of the leg, it is covered by the gastrocnemius and soleus muscles; lower down, by the long flexor of the great toe, and the deep-seated aponeurosis which passes over that muscle and the tibialis posticus. From its origin to the point at which it divides above the ankle, the peroneal artery merely furnishes small ramuli to the tibialis posticus, peronæus longus and brevis, the gastrocnemius and soleus, the long flexor of the great toe, and the fibula. It then terminates in the following branches:

α. *Ramulus peronæus anticus.* The *anterior peroneal artery* is generally small, and is sometimes wanting. It perforates the interosseous ligament about two inches above the malleolus, to reach the anterior part of the leg, whence it ranges obliquely downwards and outwards beneath the peronæus tertius muscle. In the vicinity of the anterior face of the ankle joint, it divides into numerous ramusculi, which are distributed to the articulation, the dorsum of the tarsus, and the outer portion of the foot. Some of its ramifications turn inwards to anastomose with the tarsal branch of the anterior tibial artery. Others incline outwards, below the external malleolus, and anastomose with the posterior peroneal ramulus, and the external plantar artery.

When the anterior tibial artery is absent, or preternaturally small, this branch supplies its place; and in such cases it is very large.

β. *R. peronæus posterior.* The *posterior peroneal artery* (*Fig.* 24. *i.*) preserves the direction of the main artery. It descends behind the external malleolus, posterior to the tendons of the peronæi muscles, and where it reposes upon the external surface of the os calcis, divides into numerous ramusculi, some of which pass into the substance of that bone; others pass backwards to anastomose with the branches of the posterior tibial; while many of them are spread out upon the dorsum of the tarsus and the abductor muscle of the little toe,—the first to anastomose with the tarsal and anterior peroneal arteries, the others with the external plantar.

The posterior tibial artery, after it gives origin to the peroneal ramus, does not furnish any important branches until it is about to turn into the sole of the foot (*Fig.* 25. *a.*), where, as previously remarked, it terminates by dividing into the internal and external plantar arteries. In its descent down the leg, it merely furnishes small ramuli to the adjacent muscles, and near the middle of the member, one which penetrates the posterior face of the tibia in an oblique direction from above downwards. This is the *r. nutritius tibiæ*, which enters the medullary canal of that bone, and is expended upon the marrow. Near the internal malleolus, it also sends small branches forwards to anastomose with the anterior peroneal ramulus,—and others which go backwards, towards the tuberosity of the calcis, to anastomose with the posterior branch of the peroneal artery.

b. *R. plantaris internus.* The *internal plantar artery* (*Fig.* 25. *d.*) passes directly forwards beneath the tibial margin of the foot, as far as the first phalanx of the great toe. It glides first beneath the internal annular ligament of the tarsus, and above the posterior part of the abductor pollicis;—afterwards along the lower surface of the short flexor of the great toe, parallel with the tendon of the long flexor, and beneath the first metatarsal bone. At its origin, a small branch is reflected backwards along the surface of the calcis, towards the tuberosity of that bone; and as it advances, it gives ramusculi to the abductor and flexor muscles of the great toe,—also to the integuments of the inner part of the foot, some of these winding round the inner part of the tarsal and metatarsal bones to anastomose

Fig. 25.

a, Posterior Tibial Artery. *b*, Branch to Os Calcis. *c*, External Plantar. *d*, Internal Plantar. *e*, Commencement of the Plantar Arch. *f, f, f, f*, Digital Arteries. *g*, Anastomosis.

with the arteries on the dorsum; and at its termination, it divides into several small ramuli, which are expended upon the teguments of the great toe.

c. *R. plantaris externus.* The *external plantar artery* (*Fig.* 25. *c.*) is much larger than the preceding, and may be regarded as the continuation of the posterior tibial artery. From the inner side of the calcis, it proceeds obliquely forwards and outwards, towards the base of the fifth metatarsal bone; it then passes forwards a small distance, and finally sweeps across the sole of the foot (*Fig.* 25. *e.*) to the interval which separates the first from the second metatarsal bone, where it anastomoses with the communicating ramus of the anterior tibial artery, thus completing the plantar arch, the convexity of which is directed forwards and outwards,—the concavity backwards and inwards. In pursuing this course, the external plantar artery passes first between the os calcis and the head of the abductor pollicis; then between the short flexor of the toes and the accessory muscle. Near the outer part of the foot, it is quite superficial, and reposes between the abductor and short flexor of the little toe; but where it sweeps across beneath the posterior part of the metatarsal bones, to reach its termination, it runs between the interossii muscles and the tendons of the common flexors.

In the first part of its course, and before it begins to form the arch, the external plantar artery furnishes numerous ramusculi to the muscles and other structures in the sole of the foot, which anastomose with the internal plantar artery. In the vicinity of the fifth metatarsal bone, several pass upwards to supply the teguments, and anastomose with the peroneal and tarsal arteries. From the arch itself, ramuli are distributed backwards, upwards, and forwards.

α. The *posterior branches* proceed directly backwards and are expended upon the deep-seated parts in the sole of the foot, some of them supplying the articulations of the tarsal bones.

β. *R. perforantes.* The *perforating arteries* are three small branches, which arise from the upper portion of the plantar arch. They plunge into the interossii muscles, between the metatarsal bones, and after supplying them, pass to the dorsum of the instep, where they anastomose with the branches of the anterior tibial artery.

γ. *R. digitales.* The *digital arteries* (*Fig.* 25. *f.*) are the largest branches furnished by the arch, from the convexity of which they take their origin. There are generally four, corresponding to the four last toes, which are designated numerically, counting from without inwards.

The first arises opposite the fifth metatarsal bone, and advances obliquely forwards and outwards to the fibular side of the little toe, upon which it is expended, after giving branches to the flexor brevis and adductor minimi digiti. The second advances along the fourth metatarsal space to the vicinity of the first phalanges, where it divides into two branches, one of which supplies the tibial side of the little toe,—the other the fibular side of the toe next to it. The third and the fourth are disposed in the same manner, as regards the third and second interosseous spaces, and the corresponding toes, each of them dividing into two collateral branches, which are distributed upon opposite sides of the toes they are destined to supply, in the manner already described. The great toe alone, and the tibial side of the second toe, are supplied from the anterior tibial artery: all the rest derive their vessels from the plantar arch.

Three of the digital arteries, just before dividing, send a small branch upwards through the anterior extremity of the corresponding interossii muscles, to inosculate on the dorsum of the foot, with the metatarsal branch of the anterior tibial artery. They are denominated *anterior perforating arteries*, to distinguish them from the posterior, which are furnished by the arch. The collateral arteries of the toes advance forwards to the tip of each of those members, forming frequent anastomoses with each other, and at their termination, the branches from opposite sides inosculate to form an arch (*Fig.* 25. *g.*) in the same manner as in the fingers.

Varieties of the anterior and posterior tibial, and peroneal arteries:

The *anterior tibial artery* is occasionally much smaller than natural, or altogether absent in the lower part of the leg. In such cases, its place is generally supplied by the anterior peroneal ramulus, which perforates the interosseous ligament, and forms the dorsalis pedis. (Tiedemann.) In some instances, when this artery is wanting, branches are sent from the posterior tibial artery to compensate for the deficiency. Pelletan reports the case of a man, whose anterior tibial artery lay so superficial, that its pulsations excited at first a suspicion of the existence of aneurism. The same anomaly existed

in one of the children of the individual. (*Clinique Chirurg.* I. 101.)

Peroneal artery. This artery varies much in size and distribution. It is sometimes wanting, its place being supplied by branches from the posterior tibial. When the anterior tibial artery is smaller than usual, the peroneal is generally increased in size, to compensate for the deficiency. In such cases it occasionally supplies the dorsalis pedis. (Tiedemann.) In an example observed by Otto, it took its origin at the usual point; but a little above the ankle, turned inwards, and became united with the posterior tibial artery. (*Seltene Beobacht.* II. 63.) In a case figured by Green, the peroneal artery communicated above the heel, with the posterior tibial, by a transverse branch, and afterwards descended to the sole of the foot, to furnish the internal and external plantar arteries.

The *posterior tibial artery* seldom varies much in its distribution. A case has been delineated by Green, in which it was double,—the two vessels descending parallel with each other. When this artery is wanting, the peroneal is increased in size, and supplies its place. (Burns, Barclay, 279.) In such cases, it is remarked by Burns, that the internal plantar artery is often absent.

The varieties of the plantar and digital arteries are so numerous, that they cannot be described. Their anomalies are fortunately of but little importance.

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See also the various Treatises on Anatomy.

Art. III. *Pathology of the Arteries.* The tissues composing the arteries are not exempt from the pathological states incidental to other parts of the organization. Differing as they do in their physical and vital properties, the modifications of disease which are peculiar to each of the tunics of these vessels, are so completely lost, in consequence of their intimate union with each other, and the corresponding association of their vital acts, that with a few exceptions, it is impossible to discriminate between them. We shall be compelled, therefore, in making an exposition of their various pathological states, to consider them as they affect all the tissues collectively, and without any special reference to each individual tunic as unconnected with the rest. Considered in this point of view, the pathology of the arteries may be reduced to the following heads: 1. Modifications of relation: 2. Alterations of texture: 3. Alterations of form and volume: 4. Solutions of continuity: 5. Lesions of innervation: 6. Entozoa infesting their cavity.

The first division of the subject, comprising the varieties in the origin and distribution of the arteries, has been already considered in connexion with the special anatomy of these vessels. It only remains, therefore, to treat of the others in the order in which they have been enumerated, premising that many of the de-

tails pertaining to some of the subjects, have been already discussed in the articles *Aneurism* and *Aorta.*

§ 1. *Inflammation of the arteries.* (*Arteritis, Arteriitis, Angioitis.*) Inflammation of the arteries may be either acute or chronic: it may be confined to a limited portion of one of the vessels: it may implicate several isolated portions of one or more of them, or it may be diffused through the whole arterial system. In its various modifications and consequences, it may be characterized by increased redness of the tissues of the vessel, softening, induration, effusion of coagulable lymph and the formation of pseudo-membranes, suppuration, ulceration, mortification, various transformations of tissue, increase or diminution of the calibre of the vessel, obstruction and complete obliteration. We shall first consider the anatomical characters of each of the forms of inflammation, and afterwards treat of its causes, symptoms, diagnosis, and treatment.

a. *Acute inflammation of the arteries.* Acute idiopathic inflammation of the arteries seems to have been first noticed by Aretæus. After detailing the symptoms which characterize inflammation of the vena cava, he goes on to remark, "quibusdam et arteria secundum dorsum inflammatur; quod pulsatio in alteris præcordiis manifestat," &c. (*Aretæi Cappadocis de caus. et sig. acut. morb.* Lib. II. cap. viii.) Notwithstanding it was afterwards noticed incidentally by Boerhaave, Morgagni, and various other writers, it never attracted much consideration, until J. P. Frank pointed out its importance. He, indeed, supposed that he had been the first to discover it, and remarks, that "in violent inflammatory fevers, attended with extreme agitation of the heart and arteries, I first discovered a deep inflammatory redness of these vessels, and also of the whole venous system." (*Epit. de curand. Hom. morb.* Lib. I. § 118.) Certain it is, that with the exception of traumatic inflammation of the arteries arising from the application of ligatures and other injuries, the disease had never been properly investigated previous to his time, and to the attention which the above remark had the tendency to direct to it, are we indebted for the important information which has been subsequently developed by those who have made it a subject of inquiry. We shall examine each of its anatomical characters separately.

Redness. Acute inflammation of the arteries is generally attended with more or less redness of the lining membrane, which is either confined to one or more small points, or more extensively diffused. The intensity, and the different shades of this redness, vary much, according to the violence of the inflammation, the term of its duration, the condition of the vessels, and other circumstances placed beyond our cognizance. It may assume all the intermediate tints between a light pink, and a deep crimson, scarlet, brown purple, or even blackish hue. The deeper shades of colour are more particularly observable in the lining membrane of the arteries in connexion with the violent inflammation which follows the application of a ligature (Gendrin. *Hist. Anat. des inflammations.* II. 9. Paris, 1826.); though we have recently found the lining membrane of the aorta presenting an intense reddish-brown colour to some extent, which was associated with violent inflammation of that vessel, characterized also by a flocculent pseudo-membranous deposit upon its inner surface.

This morbid coloration may occupy the entire circumference of a portion of the vessel, or be diffused throughout the whole internal surface of the arterial and venous systems, as happened in some of the instances observed by Frank. But when the disease affects the larger arteries, it often presents itself in form of small patches, or streaks, of variable extent and configuration, which either terminate abruptly, or lose themselves insensibly in the adjacent portion of the membrane. They frequently have other spots of a healthy colour interposed between them, the whole arrangement exhibiting a variegated appearance, not unlike the figures on a piece of marbled paper.

Laennec first questioned the value of simple redness as an evidence of inflammation of the lining membrane of the arteries. He concluded from numerous observations and experiments, that it should, in a majority of instances at least, be ascribed to a simple tinting of the tunics of the vessels, occasioned either by the contact of coagulated blood after death, or the imbibition, by the tissues, of the colouring matter of that fluid. The same opinion was advocated by Hodgson, and although at first it encountered some opposition, it has since received the general sanction of pathologists, notwithstanding they all acknowledge that acute inflammation of the arteries is generally attended with more or less redness. In treating of inflammation of the aorta, we have already

considered the arguments upon which this opinion is founded, and deem it sufficient on the present occasion to remark, that no degree of redness of the arterial tunics can be with certainty pronounced inflammatory, unless it be associated with some appreciable alteration of their texture, or a deposition of coagulable lymph or pus upon their surface, or in the substance of the coats of the artery.

The true inflammatory redness is, besides, often associated with more or less injection of the *vasa vasorum*, and is not limited to the lining membrane, but occasionally extends to the fibrous and cellular tunics. This injection cannot be distinguished in the lining membrane, but is very conspicuous between that tunic and the fibrous coat. In the latter it is never very conspicuous, but if all the coats of the artery be affected, the cellular tunic will often be found intensely injected, the *vasa vasorum* forming a delicate plexus of minute vessels which traverse its meshes in every direction. This character of inflammation, however, is not always present. Bouillaud speaks of it as being rare, and although it has been designated by other pathologists as of common occurrence, it should be remarked, that even when present, it does not positively indicate the existence of inflammation, since it may be produced by many other causes. Whatever occasions much obstacle to the free passage of the blood through the heart and lungs during the agonies of death, or for some time previous to that event, is apt to give rise to preternatural injection of the entire capillary system, and the vasa vasorum among the rest. Hence, persons who have died from hanging or drowning, and those destroyed by serious diseases of the heart and lungs, often present the condition in question in a conspicuous degree. The abrupt termination of the spots or lines of redness in the surrounding parts, has been mentioned as one of the characters by which simple tinting of the coats of the vessel from imbibition may be distinguished from the red colour of inflammation, which, it has been said, loses itself by insensible shades. This opinion, which we were disposed to consider valid when the article *Aorta* was penned, we have since ascertained is not founded in fact. In the case of acute arteritis alluded to above, the intense redness of the lining membrane of the aorta exhibited the abrupt termination, the stripes, spots, geometrical figures, &c., thought to be characteristic of simple tinting; yet it was lined for a considerable distance by a soft pseudo-membranous deposit of a gelatinous consistence, and besides presented other unequivocal evidences of inflammation.

Modifications of texture. Far more positive characters of inflammation of the arteries are furnished by the alterations of texture which these vessels undergo, and the products secreted from them under the influence of this process. Shortly after the commencement of the disease, the lining membrane loses its natural smooth polished aspect: it becomes tumid, soft, irregular, uneven or villous, like the serous membranes of the splanchnic cavities when similarly affected; and the delicate substratum of cellular tissue which unites it to the fibrous coat, also becomes soft and infiltrated, so as to allow the lining membrane to be easily detached, and sometimes in considerable flakes or shreds. The fibrous coat participates in the same change: it is thickened; loses its elasticity; becomes soft, friable, and more humid than natural; acquires a reddish-yellow colour, and is converted into a kind of cellular or filamentous tissue, so destitute of consistence, that it yields under the slightest force. The cellular coat undergoes similar changes: it becomes tumid and injected, and although still retaining more of its cohesiveness than the other tunics, it is rendered much more fragile and less elastic than natural.

Albuminous and *pseudo-membranous deposits.* With these alterations of texture, there are generally developed considerable modifications of secretion. Shortly after the inflammation commences, an albuminous coagulable fluid is poured out in considerable abundance upon the inner surface of the affected vessel, where it sometimes becomes consolidated into a soft viscid pellicle, which adheres to the lining membrane, and by progressive accumulation sometimes forms a continuous flocculent pseudo-membrane of some extent, so intimately united to the internal tunic that it cannot be washed away by the stream of blood. These albuminous concretions are, however, seldom thus extensive. The plastic deposit is oftener disseminated in small spots, presenting a flocculent or tomentose appearance. Co-existent with this change, or even anterior to its occurrence, a kind of serous infiltration takes place in the areolæ of the arterial tissues, by which they are rarefied as it were, and in proportion as their cohesiveness is impaired, the presence of this fluid tends to augment their softness, and impart to them a preternatural degree

of humidity. This serous effusion is generally mixed with more or less plastic lymph, and after the inflammation has continued some time, the latter material preponderates, and occasions eventually a slight solidification and thickening of the coats of the artery, especially when the disease passes into the chronic form.

These are the phenomena observed when the inflammation seizes upon the larger arteries, as the aorta, pulmonary artery, &c. It may happen, however, notwithstanding coagulable lymph is poured out abundantly by the lining membrane of the inflamed vessel, that no albuminous concretion or pseudo-membrane will be discovered adhering to the inner surface of the artery. The torrent of blood sweeping along the inflamed membrane often carries with it the morbid secretion as soon as it is poured out, thus preventing it from becoming concrete, and leaving no trace behind, to indicate the nature of the process going on in the inflamed part. This is the reason why albuminous or pseudo-membranous deposits are so seldom observed in the large arteries as a consequence of acute inflammation, notwithstanding there is reason to believe these vessels are oftener affected with that disease, than some circumstances seem to indicate. Nevertheless, the instances in which these adventitious formations have been observed, are sufficiently numerous to establish the fact of their dependence on inflammation. In the aorta of an individual who died recently of acute arteritis and carditis supervening upon the application of a ligature to the brachial artery after amputation of the arm, we found the lining membrane of that vessel exhibiting an intense Modena-red colour, and coated over to a considerable extent with a soft viscid flocculent layer of plastic lymph, which could be readily scraped from its surface. Examples of an analogous character have been reported by Haller (*Opusc. Path.* Obs. 47. p. 127.), J. P. Frank (*Epit. de curand. hom. morb.*), Spangenberg (Horne's *Archiv. für Med. Erfahr.* V. 1814.), Weldon (Coxe's *Med. Museum.* IV. 60.), Hodgson (*Traité des maladies des artères*, &c. I. 6.), Farre (*Ibid.* 5.), Kennedy (*Med. Chirurg. Review.* II. 61.), Bayle (*Bibliothèque Méd.* 1821.), B. Coates (*N. A. Med. and Surg. Journal.* VIII. 288.), Bertin and Bouillaud (*Traité des maladies du cœur.* p. 6.), Gendrin (*Hist. Anat. des inflammat.* II. 16.), Hope (*Cyclopædia of Practical Med.* Art. *Arteritis*), Samuel Jackson (*Amer. Journ. of Med. Sciences.* XV. 296.), and others, whose authority it would be needless to quote.

When inflammation attacks arteries of smaller size, other phenomena are observed which do not take place in vessels of large calibre. Under such circumstances, besides the changes already described as taking place in the coats of the vessel, the blood itself experiences very important alterations, and that portion of it which circulates through the inflamed artery, is coagulated into a solid mass, which closes the calibre of the vessel as high as its nearest collateral branch. After the colouring matter of the coagulum is removed, a solid fibrinous plug remains, which either adheres loosely with the lining membrane, or is attached to it by the plastic lymph poured out by that tissue. (See *Obliteration and Wounds of Arteries.*) This constitutes the proper adhesive inflammation of the arteries. It is the process by which they are obliterated when a ligature is applied to them, and this obliteration or adhesion will always take place with greater promptness when the vessel is small, or has its walls closely compressed, so as to be brought in apposition. In the same way, also, arteries are obliterated which terminate in a gangrenous part, when they traverse any of the tissues of the body affected by a disorganizing disease, and when they are divided or otherwise wounded; so that while this species of inflammation is often a source of serious mischief, it likewise frequently exercises a most salutary agency.

It has been questioned by some pathologists, whether the formation of this fibrinous plug filling up the calibre of the artery, takes precedence of the injection of the vasa vasorum, the consequent development of preternatural redness of the tunics of the vessel, and the deposit of coagulable lymph; or whether it is not consecutive to those changes. The results obtained from numerous experiments seem favourable to the first conclusion. It has been ascertained, that when an artery of small size is contused or violently irritated, one of the first changes observed is the coagulation of the blood within it, which completely obstructs its cavity, while the phenomena characteristic of inflammation in the arterial tunics, only show themselves at a later period. This is precisely what takes place after the application of ligatures to arteries—in lacerated wounds tearing them across, and in violent contusions affecting their structures. The two crural arteries of a dog were exposed and irritated with cantha-

rides. On examining them two days afterward, they were found inflamed upon their external surface, and filled with a solid mass of coagulated blood. (SASSE. *Dissert. de vasor. sanguif. inflammat.* HALLE, 1797.)

These considerations induced CRUVEILHIER and others to conclude, that the obstruction of the vessel by the coagulation of the blood within, is always one of the first consequences of inflammation of the arteries. The same opinion was at one time espoused by BÉRARD (*Arch. Gén. de Méd.* X.), but subsequent observations induced him to modify his views. The necessary inference from this doctrine is, that the course of the blood through an inflamed artery must always be arrested. Finding, therefore, that there are cases in which no such obstruction takes place, because there is no coagulum formed, he was compelled to grant, that the inference will not admit of universal application. (*Dict. de Méd.* IV. 105.) It may be concluded from an impartial examination of the whole grounds of the discussion, that when inflammation is a consequence of serious injuries,—when it succeeds the application of a ligature to an artery, the operation of an intense irritant upon a vessel, &c., the sentiment of CRUVEILHIER is not without foundation. But under other circumstances, especially in those cases in which the morbid process takes place spontaneously, it is contradicted by general experience; the whole phenomena observed in such instances, clearly demonstrating, that when obliteration does take place, the primary cause of it is a deposition of plastic lymph upon the internal surface of the vessel.

Purulent secretion within the arteries. Purulent matter is seldom found in a free state within the arteries, although it is rendered probable both by reason and analogy, that it is often thrown out by the lining membrane of these vessels when affected with violent inflammation. The same cause which tends to prevent the coagulable lymph which is deposited by that tissue from accumulating, also sweeps away any purulent matter which may be poured out under similar circumstances, and it is owing to this cause, that it is so seldom met with as a character of arteritis. It is more frequently encountered either collected into small pustules or abscesses beneath the lining membrane, or in a state of infiltration in the coats of the arteries and the adjacent structures. In the article *Aorta*, we have detailed several cases on the authority of MONRO, WELCH, STORCK, WEITBRICHT, ANDRAL, and LOBSTEIN, in which that vessel was affected with suppuration and abscess. MORGAGNI reports a case in which the lining membrane of nearly the whole arterial system presented small prominences or pustules, the largest of which, when cut, poured out a soft pultaceous matter. (*Epist.* xxii. No. 28.) In an instance observed by ANDRAL, in which several lobules of the lungs seemed to be infiltrated with pus, he ascertained that the appearance was owing to the ramifications of the pulmonary artery being filled with that fluid. (*Prècis d'Anat. Path.* II. 379.) BOUILLAUD, in examining an aorta which was studded over upon its inner surface with numerous points of ossification, discovered several small purulent deposits, the fluid from which presented all the properties of genuine pus. (*Dict. de Méd. et de Chirurg. Prat.* III. 408.) In a female who died of laborious miscarriage, the spermatic arteries and veins were found red and inflamed, and filled with purulent matter; and LOBSTEIN found the arteries which ramified in the vicinity of a vomica of the lungs, containing pus. (*Traité d'Anat. Path.* II. 544.) GUTHRIE remarks, that purulent matter is often found in the umbilical artery of infants, and, with the inflammation which gives rise to it, is a frequent cause of death (*Diseases and injuries of the arteries.* p. 13.): and in a case of extensive and protracted suppuration of the hand and fore-arm, SPRENGEL found the internal membrane of the radial and ulnar arteries thickened, eroded, covered with a false membrane, and those vessels filled with pus, from the wrist to the middle of the fore-arm. (RUST'S *Magazin der Gesammte Heilkunde*, and *Journ. Complimentaire*, VIII. 87.)

The purulent secretion is sometimes prevented from being washed away, by the presence of a fibrinous mass filling up the calibre of the vessel. An example of this kind has been reported by GRAVES and STOKES. (*Dublin Hosp. Reports.*) The puriform fluid occupied the space between the fibrinous concretion and the inner surface of the vessel. In some instances, moreover, pus is found occupying the centre of a mass of this kind, so as to be perfectly isolated both from the fluid blood and the tissues of the artery. (See *Blood.*)

If in addition to these facts, the great liability of any fluid secreted by the diseased coats of the arteries, to be carried along with the tide of the circulation, be considered, and if at the same time we take into account the comparatively

limited attention which has been devoted to the examination of the arteries after death, it will appear highly probable, that the pathological state in question occurs much oftener than might be inferred from the few examples of it which have been reported.

Ulceration of the arteries. Ulceration seldom follows acute inflammation of the arteries, though a frequent consequence of the chronic form of the disease. The ulcers vary much in their size and general characters. Sometimes as small as a pin's head, they are often much larger, some of them being half an inch or more in diameter. When most superficial, they consist of slight erosions, which impart to the surface of the membrane a rough tomentose appearance. Those which are more profound, destroy the lining membrane of the vessel, and have their bottom formed by the fibrous coat; and in some of them, this tunic is also destroyed. In such cases, the cellular coat either yields before the distending force of the blood, and is dilated, so as to form an aneurismal sac, or it participates in the ravages of the ulcerative process, and a complete perforation of the walls of the artery takes place. (See *Perforation*, and *Rupture of Arteries.*)

Ulcers of the arteries of considerable depth generally have well-defined borders, which are a little elevated, in consequence of the injection and thickening of the subjacent tissues. Sometimes they are ragged and uneven, having small portions of the lining membrane detached and floating loosely in the cavity of the vessel, and very often, small masses of coagulated blood are found insinuated beneath the separated edge of the membrane, imparting to the contour of the ulcer a dark ecchymosed appearance. The bottom is generally rough and uneven, and is either covered by a layer of coagulated blood, or a darkish-coloured pellicle of a fibrinous consistence. They are but rarely found smeared over with pus, inasmuch as that fluid is carried away by the current of the blood as soon as formed. In one instance, nevertheless, a large ulcer situated behind one of the semilunar valves of the aorta, was covered with a considerable quantity of purulent matter. (Hodgson. p. 12.) In the article *Aorta*, we have referred to another case reported by Meckel, in which the whole extent of the thoracic and abdominal aorta was occupied by numerous ulcers, the surface of which was coated with pus. (*Mém. de l'Acad. des Sc. de Berlin.* XII. 1756.)

There is sometimes but a single ulcer; but more frequently there are several, of various sizes and configuration, either clustered together in a single portion of the vessel, or irregularly disseminated over its internal surface. Occasionally, indeed, nearly the whole extent of an artery has been found ulcerated at different points, leaving portions of the lining membrane in the intervals retaining a healthy character. This was the condition of the vessel in the case reported by Meckel, to which reference has just been made, and also in another instance observed by Andral, who found nearly the whole extent of the thoracic and abdominal aorta studded with numerous superficial ulcers as large as a five-cent piece. Examples of ulceration of the aorta and other arteries, unattended with perforation, have been reported by numerous authors, amongst whom the following may be cited: Morgagni (*Epist.* VII. 9. XXIV. 16. XL. 24.), Haller (*Opusc. Path. Obs.* XXII.), Theden (*Unterricht für unterwundarzte*, &c. p. 232.), Sandifort (*Obs. Anat. Path.* Lib. I. cap. ii. p. 53.), Recamier (*Journ. de Méd. Chir. et Pharm.* XI. 30.), Gendrin (*Hist. Anat. des Inflammat.* II. 42, 73.), Scarpa (*On Aneurism*), and Lobstein (*Compte rendu à la Faculté de Strasb.* p. 114. Nos. 433, 435, and 437.). Besides these, we shall have occasion, under another head, to refer to examples of ulceration of the arteries terminating in perforation.

Ulceration originates differently in different cases. 1. It consists primarily of a simple destruction of tissue by ulcerative absorption, arising from inflammation, and independently of any mechanical cause. This was probably the character of the ulceration in the cases observed by Hodgson and Andral; and Morgagni, in his Fourteenth Epistle, refers to several examples, in which ulceration of the aorta was produced, where there was no ossification of the coats of the artery to occasion such an effect by the mechanical irritation excited by the earthy concretions. 2. Ulcers of the arteries may follow the opening or rupture of small abscesses or atheromatous pustules situated beneath the lining membrane. Scarpa has particularly explained the agency of this cause in the production of aneurism. 3. They may succeed the detachment of osseous or calcareous scales deposited within the arterial tissues, the beds of which become converted into ulcerated surfaces. Laennec remarks, that the small excavations left by the separation of these scales are

filled by decomposed fibrine of the consistence of a friable paste, which is often mixed with carbonate of lime. He moreover subjoins, that their borders are frequently reddened to a small distance by the infiltration of blood, which should not be attributed to chronic inflammation. (*Traité de l'Auscult. médiate.* II. 610.) This latter inference is not altogether correct. Such ulcers are often associated with traces of inflammation too palpable to admit of a doubt of its existence. 4. Ulceration may extend from the parts surrounding an artery, so as to involve its tunics from without inwards, and in some cases completely traverse them, occasioning a formidable or fatal hemorrhage. Notwithstanding the arteries are endowed with a kind of conservative power, in virtue of which they are enabled to resist for a long time, ulceration, gangrene, and other morbid processes affecting the adjacent parts, cases not unfrequently occur, in which they are ulcerated, and even opened, by diseases proceeding from these sources. Cruikshank witnessed an instance, in which a fatal hemorrhage was induced by an erosion of the femoral artery commencing in a neighbouring bubo. (*History of the absorbent vessels.*) Similar cases have been reported by Travers and Gibbs (*London Med. and Phys. Journ.* 1827.), and Bérard (*Dict. de Méd.* Art. *Aine.*). Joseph Frank saw a fatal hemorrhage result from an ulceration of the epigastric artery, occasioned by a venereal bubo (*Prax. Med. Univ. Præcept.* II. pars. ii. 303.); and profuse hemorrhage from the lungs, stomach, intestines, &c., not unfrequently proceeds from such a lesion of one or more of their vessels. Hodgson witnessed a fatal hematemesis, which originated in an ulcer of the mucous membrane of the stomach, destroying the coats of the coronary artery of that organ; a second case, in which death was induced by ulceration of the splenic artery, communicated to that vessel by a cancerous tumour situated behind the stomach;—and a third, in which the same result took place from the ulceration of a considerable branch of the pulmonary artery, which communicated with a vomica of the lung. (*Loc. Cit.* p. 13.)

Softening of the arteries. Arteria malacia. Malacosis arteriarum. It has been already remarked, that one of the earliest effects of inflammation of the arteries is, to produce considerable softening of their tissues. It will be proper to consider this pathological condition more in detail, as the question is still unsettled, whether it should be referred to inflammation when not associated with other palpable characters of that process.

Softening of the arteries is constantly observed as a consequence of the application of a ligature to these vessels; but its characters as an idiopathic condition, supervening independently of any previous mechanical lesion, have not been studied with sufficient accuracy, to justify any very positive or satisfactory conclusions. It is characterized by a manifest diminution of the cohesiveness of one or more of the arterial tunics, most generally of the internal and middle, but occasionally also of the cellular; and this condition may be limited to a small portion of a single vessel, or be more extensively diffused, occupying a considerable part or the whole of the arterial system. Vessels thus affected are deprived of their elasticity; they are incapable of sustaining even slight force, and are disposed either to become dilated uniformly to a considerable extent, or partially, so as to lay the foundation of aneurism. The latter changes, however, seldom take place, when the softening is confined to the lining membrane, and are chiefly observed when the whole of the arterial tissues are involved. When the disease attacks the lining membrane alone, it is rendered preternaturally friable, is reduced to a pulpy consistence possessing but little cohesiveness, and can be easily scraped from the fibrous coat. It generally has the appearance of being slightly thickened, tumid, uneven, and spongy, and is devoid of the density natural to it. These characters sometimes exist unassociated with any apparent infiltration or increase of humidity, though very often the softness is increased by the admixture of more or less fluid. Lobstein alludes to a form of softening of the lining membrane somewhat different from this, which he says consists in a kind of spongy tumefaction, giving rise to vegetations of sufficient magnitude to close the vessel. This condition was observed in the innominata to the extent of half an inch, and that vessel was reduced to one-third its natural capacity by the spongy arrangement of the tissue. It was also discovered in the subclavian and carotid arteries of another individual, who during the last years of his life had experienced two or three transient attacks of syncope. These excrescences, though encroaching considerably upon the capacity of the vessel, were so soft as to be depressed by the stream of blood. (*Traité d'Anat. Path.* II. 569.; also, *Archiv. Gén.* VIII. 600.)

It is not unusual to find all the coats of the arteries rendered so friable, that they tear under the slightest force, although they exhibit no tumefaction, thickening, or infiltration of fluid. They are affected with a kind of dry softening, or in other words, their natural cohesiveness is diminished, without any other appreciable change. This condition is chiefly a consequence of chronic inflammation, or of changes in the development of which acute inflammation has no participation. Hence it is often observed in those arteries which traverse parts affected with cancerous and other degenerations.

In other cases, the softening of the fibrous and cellular coats is associated with a manifest infiltration of the parts, either with blood, serum, pus, or some other fluid. Under these circumstances, with the diminution of cohesiveness, there is a manifest increase of humidity, and all the affected tissues are soft, tumid, and spongy. This condition is often a consequence of acute inflammation of the arterial tunics, and is especially observed in the vicinity of ligatures, and in those arteries which are situated in the neighbourhood of parts affected with profuse suppuration. LOBSTEIN remarks, that he has seen the coats of the arteries converted into a spongy tissue, analogous to the corpus cavernosum of the penis, from which blood issued by an infinity of orifices when the vessel was divided. This was observed in the arteries of the extremities; and a case is reported in the *Journal de Médecine*, an. xi. p. 41, in which the radial artery presented a tumour of this kind, affecting its coats to the extent of two inches. When divided in the living subject, it bled freely; and when examined after being extirpated, it was found to consist of a spongy mass, infiltrated with blood. (*Traité d'Anat. Path.* II. 569.)

We are not as yet in possession of any very certain criteria, by which we can distinguish the form of softening which is a consequence of inflammation, from another modification of the same condition of the tissues, which seems to arise solely from defective or imperfect nutrition. (See *Softening*.) In either case, the consequences of the lesion are similar. The liability of ligatures to slough away, and the proneness to secondary hemorrhage in cases where the coats of the arteries are softened, are well known; but besides these accidents, the condition in question disposes to dilatation, to the development of aneurism, and even to rupture or perforation of the artery and the induction of fatal hemorrhage. (See *Rupture*, and *Perforation*.) It has been observed by HESSE, that idiopathic softening of the arteries is very generally associated with a similar condition of the walls of the heart, and that in a majority of cases it is confined to the lining membrane. (*Ueber die Erweichung der Gewebe und organe des mensch. Körpers.* 1827.) We have seen it existing in the aorta, associated with acute carditis and pericarditis.

Gangrene of the arteries is scarcely ever observed, except when it is propagated to these vessels from a mortified condition of the surrounding parts; and even then their conservative energies enable them to resist the disease for a length of time. Very often, in extensive mortification of the extremities and other parts of the body, the main artery retains its integrity of structure in the midst of parts which are completely dead and reduced to *putrilage*, and the whole of the soft parts surrounding the vessel may slough away, dissecting it clean on every side, yet its coats exhibit no evidences of a participation in the gangrene. The arteries, nevertheless, often undergo important changes in gangrenous parts, although their vitality is not destroyed. It was long since noticed by PETIT, QUESNAI, and O'HALLORAN, that the arteries of gangrenous limbs do not bleed on amputation being performed in the vicinity of the dead part. This they discovered was owing to the vessel being rendered impervious by a firm fibrinous coagulum, which, while it plugs up its calibre, adheres intimately to its lining membrane. In one case observed by O'HALLORAN, no hemorrhage took place, although the incision was made four inches above the line of separation between the dead and living parts. The simple coagulation of blood, THOMSON thinks, is not of itself sufficient, without the concurrent agency of adhesive inflammation; and he affirms, that in several cases which he examined where no bleeding occurred on the division of the vessels, no such coagulum existed. (*Lectures on Inflammation.* p. 437.) We have several times inspected the arteries of mortified limbs, and have almost invariably discovered considerable thickening of their tunics, together with small masses either of fibrinous concretion, or of albuminous deposit, existing within. In nearly all cases, they have been found partially or completely obstructed, and this condition generally extends as high as the origin of the nearest collateral vessel above the line of separation of the dead from the living parts.

b. *Chronic inflammation of the arteries. Arteritis chronicus.* Chronic inflammation of the arteries is probably a disease of frequent occurrence,—at least the lesions of their tissues which have been generally attributed to this cause, are perhaps as often met with as alterations of structure of the other organs. How far they can be with justice all ascribed to inflammation is still a question with pathologists, and we are not as yet in possession of sufficient data to offer a satisfactory solution of the problem. In order, therefore, to group all the alterations of texture to which these vessels are liable under one head, we shall proceed to describe them under the present section—pursuing, in this respect, the same order we adopted in treating of inflammation of the aorta.

Redness, which has been spoken of as a character of acute inflammation of the arteries, seldom exists in the chronic form of the disease. The lining membrane, on the contrary, exhibits a dull yellow, or grayish-brown colour, and often presents a variegated or mottled appearance, owing to the diversity of tints possessed by the several textural alterations existing in its tunics. In some instances, nevertheless, especially where the coats of the vessel are studded over with calcareous scales or points, the portion of the lining membrane corresponding to the contour of these deposits, presents a dark red, ecchymosed appearance. Where cracks and fissures exist in the membrane, this redness is sometimes owing to a small quantity of blood becoming insinuated beneath it, and affords no evidence of inflammation. But in other cases, it is occasionally associated with manifest injection of the vasa vasorum, and is indicative of preternatural irritation of those vessels, either supervening as a consequence of the mechanical influence of the calcareous deposits, or existing independently of them, and consisting in a degree of inflammation owing its origin to some other cause.

Hypertrophy with induration (*Arteria sclerosis*) of the tunics of the arteries is a very frequent consequence of chronic inflammation. Hodgson remarks, that the lining membrane is sometimes thickened, and converted into a structure similar in character to the peritoneal envelope of an old hernia. If, observes he, the tunics be separated, it will be found that the disease is confined to the inner coat, which, deprived of its elasticity, and rendered preternaturally fragile, is often traversed by small fissures, which thus break it up into scales, having their margins projecting slightly into the lumen of the vessel. (*Op. Cit.* p. 15.) From the result of our own investigations, we are rather disposed to refer the origin of this change, as well as many others generally attributed to the lining membrane of the arteries, to the delicate substratum of cellular tissue which connects that tunic to the fibrous coat; and in this opinion we are supported by the analogy furnished by the lesions of other serous membranes, the majority of which have their origin in the cellular tissue, uniting the proper serous pellicle to the surrounding parts. The thickening in question may occupy the artery to a considerable extent, either diffused with uniformity, or arranged in form of small isolated portions, separated by irregular lines ranging in various directions. The elevated points corresponding to the thickened parts of the membrane, are generally owing to albuminous or other deposits in the meshes of the cellular tissue situated between the lining membrane and the fibrous tunic. This condition is oftenest observed in the aorta, and the primitive arterial trunks. Lobstein states that he had never observed it in the arteries of the upper parts of the body, but often in those of the lower extremities, in which it existed in form of transverse rugæ, imparting to the inner surface of the vessel an appearance analogous to that of the mucous membrane of the vagina, the folds of which have not been obliterated. (*Op. Cit.* II. 551.)

The same species of alteration frequently occurs in the fibrous tunic. It becomes preternaturally thickened; is rendered so friable as to yield under a slight degree of force; acquires an unnatural degree of density, and, withal, is deprived of all traces of elasticity. According to Andral, it is sometimes so much thickened, that it becomes as conspicuous as in the horse; and this we have witnessed several times. It would occur more frequently, were it not, that in proportion as the changes take place, the vessel becomes preternaturally dilated, thus tending to give rise to more or less attenuation of its tunics, which would otherwise present an unusual degree of thickness.

The cellular coat undergoes the same changes as the common cellular tissue, when exposed to similar influences. It loses its filamentous character, adventitious deposits are formed in its meshes, and its density is increased. It seldom,

however, becomes so friable as the internal and middle coats; and frequently when they give way, it sustains the entire distending influence of the column of blood, and becomes dilated to form an aneurismal sac.

The coats of the arteries sometimes undergo a species of atrophy. This is more particularly true of the fibrous tunic, the peculiar texture of which is rendered so indistinct in such cases, that it is scarcely perceptible even in the large arteries. In this condition, the vessels are less elastic than natural; their volume is sometimes diminished, and when exposed, they collapse like veins. In many cases, attenuation is associated with preternatural dilatation; and these alterations may be of small extent, or they may affect nearly the whole arterial system. (See *Dilatation.*)

Atheromatous deposits in the coats of the arteries. There are few pathological states of the arteries of more frequent occurrence, especially in advanced life, than a deposit of a peculiar kind of matter between their internal and middle coats, denominated atheroma. This material is secreted by the vasa vasorum of the diseased tissues, and varies much in its characters. It sometimes resembles pus, but is often of a much thicker consistence, and may be compared to thick pap, or soft cheese. Small particles or flakes are frequently intermixed with a thinner fluid, and when rubbed between the fingers, it imparts something of a greasy or saponaceous feel, blended with which, minute gritty particles can be distinguished, like grains of sand, or the small calcareous particles often discovered in the matter furnished by a disorganized bronchial gland. They probably consist of minute granules of phosphate of lime, which are disseminated through the other materials of the secretion. This deposit is at first disposed in small isolated points, of a yellowish straw colour, situated beneath the lining membrane; but as the matter accumulates, the inner surface of the artery often assumes an uneven pustular appearance, the membrane being elevated above its natural level. Several of these pustules often become confluent, and give rise to irregular patches of variable extent, which render the surface of the vessel rugged and uneven. Though situated at first in the meshes of the delicate cellular tissue which unites the serous to the fibrous tunic, the influence of these collections sooner or later implicates both their structures, generally rupturing the first, and giving rise to a small ulcer of the kind described above,—impairing at the same time the elasticity and cohesiveness of the fibrous coat, and afterwards destroying its texture, so as to lay the foundation of aneurism.

This atheromatous secretion may be confined to a limited portion of a single artery, or it may be more extensively diffused,—the small yellowish points in question being unequally disseminated over the inner surface of these vessels to a considerable extent, or through the whole arterial system, especially in all the arteries of considerable size. The quantity of atheromatous matter deposited is seldom so great as to encroach materially upon the capacity of the vessel,—yet this sometimes happens; and Hodgson states, that he found the femoral and emulgent arteries obliterated by it in the same subject. (*Op. Cit.* p. 19.) When considerable, it always impairs the elasticity of the vessel, renders its coats preternaturally friable, and is often associated with more or less dilatation. It is unquestionably the most fruitful source of spontaneous aneurism; and it sometimes gives rise to perforation or rupture of the larger arteries.

The precise nature of these atheromatous deposits is not properly understood, nor are the sentiments of pathologists in accordance, in regard to the modifications of vital action by which they are produced. By some, the matter of atheroma is considered analogous to tubercle, while others regard it as the inceptive stage of the calcareous transformation, to which the arteries are so liable in advanced life. The fact that it is often associated with this latter condition is well established, small granules, or even scales, of calcareous matter being frequently found occupying the atheromatous patches or pustules. The question has also been mooted, whether it should be considered as one of the multifarious products of inflammation, or merely as a consequence of perverted nutrition or secretion, originating in some other modification of vitality. The solution of this question can only be obtained when a more accurate definition of what is meant by inflammation shall have been given than any we now possess, since under the vague application of that term, at present in general use, it may be made to embrace nearly every known lesion of the organization, or be restricted to a few of them, according to the particular views of the pathologist. By some it has been asserted, that this morbid secretion is deposited primarily in the proper substance of the

lining membrane. It has been represented recently by Bérard, that it is lodged between the two layers of this tunic, and that if the disease be examined in the early stage, by stripping off the membrane, the atheromatous points will all be removed with it. (*Dict. de Méd.* IV. 132.) There is nothing to justify such an inference. In the first place, we are not disposed to allow that the lining membrane is composed of two layers, although it has been so represented by Haller and Mascagni; and when the appearance in question is observed, it is in consequence of an attenuated stratum of the fibres of the middle coat being peeled off with the lining membrane,—an occurrence which almost constantly happens in attempting to separate them. We have repeatedly detached the lining membrane entire from the surface of these deposits, leaving them behind, and we are satisfied, from numerous examinations, that their primary seat is the cellular tissue situated between the serous and fibrous coats of the artery.

Steatomatous degeneration of the arteries. It would be exceedingly difficult to define accurately what pathologists wish to express by the term steatomatous degeneration of the arteries. By some it is not distinguished from the atheromatous secretion already described. Others apply the term to that matter when it assumes a solid or consistent form; while by some, the steatomatous development of the arteries is said to consist of irregular tubercles or masses, of a yellowish fawn colour, and of the consistence of bees-wax, cheese, or firm suet, occupying the substance of the arterial tunics. Having never observed any pathological condition of the vessels corresponding to this definition of steatoma, we shall be obliged to content ourselves with an enumeration of the characters which have been ascribed to it by others. According to Craigie, who speaks of it as of frequent occurrence, the disease commences in form of small irregular patches, of yellowish or fawn-coloured matter like wax, which appear on the inner surface of the proper coat. As the process of deposition advances, these become thicker and broader. They coalesce, and sensibly raise the outer filamentous coat; while by their prominence interiorly, they diminish the capacity of the arterial tube. At the same time, the inner membrane becomes irregular, opaque, and shrivelled, and the connexion with the fibrous coat being destroyed, it is detached with great facility. (*Treatise on General and Path. Anat.* p. 97.) He also represents, that although the steatomatous deposit may occur probably in any portion of the arteries, it always commences precisely at the point of their bifurcation, and when it occupies any extent of the tube, it will be found to have begun at the bifurcation, and spread thence along the vessel.

The steatomatous matter is sometimes blended with small earthy particles or fragments of ossification; but it is often unassociated with that deposit, and seems to be of a homogeneous consistence. It always impairs the elasticity of the coats of the artery, diminishes their cohesiveness, and sometimes leads to a rupture of the walls of the vessel, or to the development of aneurism. Although frequently followed by ulceration, like the atheromatous secretion of the vessels, the sweeping assertion of Scarpa, that it is always disposed to take on that process, must not be admitted without some limitation.

Next to the tendency of these tumours to destroy the coats of the artery, and to occasion aneurism, we may mention their liability to encroach upon the capacity of the vessel, and impede or obstruct the course of the circulation through it. These effects are seldom produced, except when the tumours attain a considerable size, in which case, they may occasion the complete closure of even the largest arteries. The most remarkable case of this kind, of which we have any account, is one described by Stenzel. (*Dissert. de steatomatibus aortæ recus.*, in Haller's *Disput.* II. 527.) The aorta was occupied by two large steatomatous tumours, one of which implicated the arch; the other was situated a little lower down in the upper part of the thoracic portion of the vessel. Such was the magnitude of these tumours, that they distended the aorta until it almost equalled the volume of the heart, and encroached so much upon its calibre, that there was scarcely sufficient room left to admit the passage of the blood. They were firm and unyielding to the touch, and when laid open, were found to be surrounded by a thick whitish membrane of a more compact consistence than leather. The cavity was occupied by a solid substance resembling tallow or adipose matter.

We doubt much the propriety of the term applied by Stenzel to these tumours. It is highly probable, from the expression, colore albicante ad incarnatum accedente prædita, *striisque multis per totam superficiem notata oculis occuribat nostris*, and other parts of the description, that they

were truly large aneurisms of the aorta, which had been cured spontaneously by the successive depositions of fibrinous concretions within the sac. In the article *Aorta*, p. 157, we have referred to two cases reported by Corvisart, which there is much reason to suspect were of the same nature, and several analogous examples might be cited. From all the characters which have been detailed in the reports of such cases, it is much more rational to adopt the sentiment of Hodgson —that these supposed steatomatous tumours were merely examples of aneurismal sacs, which had been gradually obliterated by changes taking place within them, than any special degeneration or new product developed within the proper arterial tunics. If this view of the subject be correct, it is improper to apply the term steatoma to such productions, and the necessity of circumspection will be manifest, in order not to confound them with those deposits and excrescences, sometimes formed by the coats of the arteries, to which that appellation is more properly applicable. Of the effects of steatomatous and various other tumours and excrescences, which occasionally form in the coats of the arteries, we shall speak under the head of *Obstruction*.

Cartilaginous transformation. We have already spoken of thickening and induration of the arteries. When this condition advances still further, the coats of the vessel acquire a proper cartilaginous consistence. By those who have contended that the calcareous transformation of the arteries is the result of a process identical with ossification, this cartilaginous condition has been represented as one of the intermediate stages between the simple deposit of coagulable lymph, and its final conversion into the calcareous plates which occupy the arterial tunics. The fact that the two pathological states are often found associated, and that the contour of a calcareous scale is frequently surrounded by a portion of the tissue possessing the consistence of cartilage, seems favourable to this inference. Yet it must be admitted, that in a large proportion of cases, the development of the earthy deposits is not preceded by the conversion of the tissues into cartilage. It sometimes exists in small whitish or yellowish-coloured isolated points, intimately adherent to the lining membrane; but frequently it extends to all the tunics, occupying them to a considerable extent, and converting the artery into a firm rigid and inelastic cylinder. Though probably a consequence of chronic inflammation, this cartilaginous state is never associated with any preternatural redness or injection of the vasa vasorum.

Calcareous transformation. Ossification of the arteries. (Lithiasis arteriarum.) Decidedly the most common of all the pathological states of the arteries is, the development, within their tunics, of small irregular plates, or scales, of calcareous matter, constituting what is denominated ossification. It occurs so frequently in advanced life, that according to Baillie, it is oftener observed at that period than the natural condition; and Bichat estimated the ratio of cases in which it exists after the age of sixty, as seven in ten. The form, size, and arrangement of these earthy deposits are almost infinitely variable. Examined in the inceptive stage of their formation, they generally consist of minute isolated opaque points, or specks, of a yellowish or whitish colour, often incorporated with more or less of the atheromatous matter already described. Sometimes the coats of the arteries present small opaque patches of a cartilaginous consistence, the centre of which is occupied by one or more small earthy granules. But when their development has advanced further, the coats of the artery are rendered rough, rigid, and inflexible, by numerous irregular plates or scales of a firm earthy consistence, which vary in size and figure, but generally have their surfaces flattened, and that which looks towards the cavity of the vessel smoother and more uniform than the other. If the transformation has advanced very far, the edges of these plates approach so near to each other, as scarcely to leave any of the arterial tunics of a healthy consistence between them, the whole extent of the diseased vessel being converted into a firm unyielding calcareous cylinder, totally divested of its natural attributes, which when forcibly compressed, may be broken down into numerous fragments like an egg-shell. Should the transformation be less considerable, the points or scales are more sparsely arranged, and are often separated by portions of the artery of considerable extent, in which the tunics retain their healthy characters. In some instances, the calcareous matter is not deposited in form of flattened scales, but is disseminated in thick projecting masses, exceedingly rough and irregular upon their surface, exhibiting more of the characters of small irregular pebbles, than of

a proper organic transformation. This variety is, however, of much rarer occurrence than the preceding, and is seldom observed, except in the angle formed by the bifurcation of two vessels. There is still another form assumed by these concretions, which has been supposed to have a different origin from either of the others. It consists of numerous circular masses, passing partially or completely round the vessel, and corresponding to the direction of the fibres of the middle coat. These fragments are generally interrupted by portions of the coats of the artery which retain something of their healthy texture, and thus impart to the vessel a kind of articulated appearance. They have been supposed to consist especially of a transformation of the fibrous coat, the scales and plates already described having their origin either in the serous coat, or the cellular tissue by which its adherent surface is attached. These annular concretions are never found in the aorta, and are most frequently observed in the femoral and other arteries of the lower extremities.

The question as to the precise seat of the calcareous or osseous transformation of the arteries still remains unsettled. De la Sonne long since affirmed, that the deposit takes place in the substance of the lining membrane (*Mém. de l'Acad. Royale.* 1756.), and this opinion has been more recently advocated by Hodgson (*Op. Cit.* p. 24.), Cruveilhier (*Essai sur l'Anat. Pathologique.* II. 67.), Meckel (*Manuel d'Anat.* I. 154.), Craigie (*General and Path. Anat.* p. 91.), Guthrie (*Diseases and injuries of the arteries.* p. 23.), and Bérard (*Dict. de Méd.* IV. 129.). Bichat located it in the outer surface of that membrane (*Anatomie Générale.* Edit. par Blandin. II. 63.), and Scarpa (*Tratto sull' aneurism*), Andral (*Prècis d'Anat. Path.* II. 381.), Otto (*Lehrbuch der Pathologisch. Anat.* I 340.), Lobstein (*Traité d'Anat. Path.* II. 561.), Breschet (in Meckel, *Loc. Cit.*), Hope (*Cyclopædia of Pract. Med.* Art. *Arteritis*), and Copland (*Dict. of Pract. Med.* Art. *Arteries*), represent, that the disease commences in the delicate filamentous tissue which unites the serous to the fibrous coat of the arteries. The correctness of this opinion seems to be confirmed both by dissection and the analogies furnished by other serous membranes; nor are we disposed to admit the existence of the two laminæ of the lining membrane of the arteries recognized by Haller, Mascagni, Cruveilhier, and Bérard, and which the two latter individuals have appealed to, in support of their pathological views upon this point.

By some, it has been supposed that this species of transformation sometimes commences also in the fibrous coat. Those who have adopted this opinion, affirm that when the fragments exhibit an annular arrangement, and extend round the entire circumference of the vessel, it is owing to the metamorphosis of the circular elastic fibres of the vessels into these calcareous rings. Blandin has indeed affirmed, that the ossification of the arteries which is of such frequent occurrence in old age, always takes place in the fibrous coat, while that which is observed at an earlier period, commences between this tunic and the lining membrane. (Bichat. *Anat. Générale.* II. 67. Note.)

However this may be, the coats of the vessel in which the earthy deposit is made, experience important modifications. The lining membrane is elevated upon the surface of the concretion, and in the early stages of the disease, adheres intimately to that face of it which is directed inwards, in form of a thin pellicle, so as to be interposed between the calcareous scale and the column of blood. Bichat, however, was incorrect in affirming that it seldom becomes destroyed. Contrary to this, it is often found where the plates are numerous and large, that the lining membrane presents numerous cracks or fissures, through which the edges and angular prominences of the adventitious masses project, so as to be placed in direct contact with the stream of blood. This latter fluid, indeed, sometimes insinuates itself beneath the edges of the ruptured membrane in the vicinity of these crevices, and imparts to it a dark ecchymosed appearance, which upon superficial examination might be mistaken for inflammation. The fibrous coat is divested of its natural elasticity and pliancy; it is sometimes increased in thickness, and rendered preternaturally friable; but more frequently, it either experiences a considerable degree of atrophy, or becomes partially or completely supplanted by the calcareous deposit. These changes, together with those which take place in the lining membrane, so enfeeble the coats of the artery, that they either yield before the lateral distension occasioned by the blood, and lead to the development of aneurism, or they become ruptured, and a fatal hemorrhage takes place. The cellular coat, though less liable to these changes than the others, often has its texture considerably modified, and in some instances, the

adventitious deposits encroach so much upon it, as to leave but few vestiges of its natural structure.

There is probably no portion of the arterial system exempt from this calcareous transformation, though it occurs much more frequently in some arteries than in others. It attacks the aorta oftener than its several branches, and as a general rule, the latter are more liable to it than their several divisions and subdivisions. Ossification of the aorta is indeed so common in advanced life, that it is perhaps more frequently observed than its natural condition. It should, nevertheless, be observed, that cases occasionally occur, in which this vessel is entirely exempt from this change, while the arteries of the extremities are extensively ossified. LOBSTEIN states that he has witnessed several such examples, and some of the same kind have fallen under our own observation. The extent to which it becomes thus affected is sometimes so considerable that it is converted, to the extent of several inches, into a solid earthy cylinder, so rigid and unyielding, as to accommodate itself with difficulty to the ordinary flexures of the body. Ossification of the coronary arteries is very often observed. It was long ago particularly described by CRELL (*Obs. de arteriar. coron. instar ossis induratis*), and was besides noticed by BELLINI, MECKEL, SENAC, MORGAGNI, and others. Much importance was attached to its influence on the heart, and more recently it has been supposed by PARRY and others to constitute the cause of angina pectoris. The arteries of the neck and head are also often found ossified, especially the common and external carotids, and the branches of the latter. The trunk of the internal carotid seems to be less frequently affected, and LOBSTEIN remarks, that he has seldom discovered points of ossification involving any other portion of it, than the curvature which is lodged within the petrous portion of the temporal bone. The vertebral artery is very often the seat of this calcareous deposit. MORGAGNI remarks, that he has seen the basilar artery presenting points of ossification, and we have more than once witnessed the same condition of this vessel, as well as of most of the arteries of the brain, in aged persons. It often lays the foundation of apoplexy in advanced life, and predisposes to other affections of this organ. Sometimes, indeed, this morbid alteration seems to extend even to the small twigs of the vessels of the brain. In one case observed by LOBSTEIN (*Traité d'Anat. Path.* II. 557.), the minute ramusculi penetrating the medullary substance of that organ were so firmly ossified, that in attempting to slice it, they resisted the scalpel, and could be drawn out in form of minute osseous tubes of a filamentary appearance. The individual's age was not more than forty-seven, and he had not died of any disease of the brain. It is not unusual to find small masses of these earthy concretions occupying the origin of the innominata, and the subclavian arteries. They sometimes project considerably into the cavity of the vessel, and ANDRAL thinks, may be instrumental in producing the difference of the pulse in the two wrists in old persons. Similar masses also exist in the bifurcation of other vessels, and in some instances, they no doubt tend to modify the currents of blood at those points.

We have often found the cœliac artery extensively ossified, but have never observed this lesion in any but its splenic branch, in which it is of common occurrence. ANDRAL remarks, that it is rarely observed in the hepatic artery, and the coronary of the stomach; and LOBSTEIN declares that he had never found either of those vessels affected with it. In the emulgent arteries it is common; also in the spermatics. The trunks of the mesenteric arteries are also frequently affected, but their branches very generally escape. The museum of the University of Maryland contains a specimen of ossification of the branches of the hypogastric artery, and several examples were observed by HALLER, who also witnessed this affection in the arteries of the penis. It is likewise very common in the uterine arteries, and according to LOBSTEIN, sometimes even affects their smallest ramifications. The same author remarks, that in one case, he found the uterine surface of the placenta presenting numerous points of ossification, which, on being carefully examined, were found to correspond to the vascular ramifications, and presented themselves in form of osseous ramusculi. (*Op. Cit.* p. 556.)

The liability of the arteries of the extremities to this alteration is well known. Yet it is somewhat remarkable, that it should occur so much more frequently in the lower than in the upper members. LOBSTEIN concludes, from numerous observations, that the instances in which the femoral arteries and its branches are found ossified, compared to those in which the brachial artery and its numerous divisions are affected, may be estimated in the ratio

of 30 to 1; and he remarks, that in two individuals—one aged one hundred and four, the other ninety-six, in whom he expected to find all the arteries ossified, those of the upper extremities furnished no trace of this condition, while the femoral arteries and their branches were affected throughout nearly their whole extent.

Bichat, assuming the ground that the vessels which circulate black blood are not liable to ossification, affirmed, that the pulmonary artery is exempt from this condition. The truth of this assertion is contradicted by several examples, recorded both before and since his time, of ossification of different veins, and also of a similar affection of the pulmonary artery, and the valves of the right side of the heart. Yet it must be confessed, that such instances are comparatively rare. In upwards of two thousand bodies which we have either examined or witnessed when opened, we have never seen more than small cartilaginous points affecting the coats of this artery, some of which contained minute particles of calcareous matter. It is stated by Cruveilhier (*Essai sur l'Anat. Path.* II. 53.) that Gemma and Veslingius discovered small osseous concretions at the orifice of the pulmonary artery. In a case observed by Chomel, this vessel was occupied both externally and internally by calcareous masses. (*Hist. de l'Acad. Roy. des Sc.* 1707. *Obs. Anat.* 3. Also, Morgagni, XXVII. 20.) Marchetti found an earthy concretion occupying the orifice of the pulmonary artery of an individual who died of dropsy. (Bonetus. *Sepulchret.* Lib. III. sect. 21. § 22.) Morgagni observed a case in which the orifice of this vessel was nearly closed up by such concretions (*Epist.* xxvii.), and Grimm reports an example of ossification of the pulmonary artery of an ox. (*Ephem. Nat. Cur.* Dec. II. An. III. Obs. 38.) In the body of a female, aged seventy-four, Stoll found numerous small granules and points of ossification disseminated over the internal surface of this vessel. (*Ratio Medendi.* I. 136. Sect. 9.) According to the report of Lobstein, an example of this species of transformation is contained in the Anatomical Museum at Strasbourg. (No. 434.) The osseous mass was seven lines in length, by five in breadth, and three in thickness. It was situated at the orifice of the ductus arteriosus, and was covered by the lining membrane of the artery. The whole length of the ductus arteriosus was also ossified. He observed a second case of the same kind, except that the ossification was partial. (*Traité d'Anat. Path.* II. 562.) Otto also refers to a specimen of ossification of the pulmonary artery, which he witnessed in the Anatomical Museum of Freiburg. It occurred in a young subject, who fell a victim to consumption. (*Lehrbuch der Path. Anat.* I. 341.) Besides these, the following cases have been referred to by Hodgson and Otto, as examples of ossification either of the pulmonary artery or its valves: Senac (*Traité de la structure, &c., du cœur.* II. 402.), Haller (*Opusc. Path. Obs.* LIX.), Burnet (*De Polyposib. concret. in pect. morb.* Altd. 1729.), Mohrenheim (*Wiener Beitrage.* XI. 215.), Pohl (*De ossif. vasor. præternat.* Lips. 1774.), Baader (*Obs. Med. incis. cadaver. anatomie illustrat.* Frib. 1775.), Bach (Richter's *Chirurg. Bib.* VIII. 498.

It is thus manifest, that the transformation is liable to take place in every portion of the arterial system, and notwithstanding it is but rarely observed in some of the arteries, no one of them possesses an entire immunity. According to extensive investigations made by Lobstein, the following is the order of liability of the different arteries to undergo this alteration:

"The arch of the aorta;
The angle formed by the division of this artery into the two iliacs;
The thoracic aorta;
The splenic artery;
The abdominal aorta;
The femoral artery and all its branches;
The spermatic arteries;
The internal iliac and its branches;
The coronary arteries of the heart;
Some of the branches of the subclavian;
The angle of division of the common carotid;
The inflexions of the internal carotid;
The cerebral arteries in a state of *cartilaginification.*
The branches of the external carotid;
The arteries of the walls of the thorax and abdomen;
The brachial artery and its ramifications;
The ramifications of the umbilical artery;
The small arterioles which plunge into the substance of the brain;
The pulmonary artery."—(*Traité d'Anat. Path.* II. 558.)

Although ossification of the arteries has been generally regarded as a kind of inseparable appanage of old age, it is not exclusively confined to this period of life; nor does it always exist even in the most

aged. We have several times had subjects on the dissecting table, apparently of great age, in whose arteries no traces of this transformation could be discovered. ANDRAL remarks that he examined a female of upwards of eighty, without finding any indication of ossification, notwithstanding the bronchial ramifications were converted into firm cartilaginous and osseous tubes. (*Prècis d'Anat. Path.* II. 380.) Nor are cases wanting, in which the arteries even of young subjects have been found affected with this condition. COWPER found the arteries ossified in a man aged thirty years. (*Philosoph. Transact.* 1705. No. 299.) PORTAL remarks that it is sometimes met with in young subjects, in whom the ossification of the bones is not far advanced. (*Cours. d'Anat. Méd.* III. 133.) YOUNG found the temporal artery of a child, only fifteen months old, converted into a complete calcareous tube. (HODGSON. *Op. Cit.* p. 27.) WILSON observed a case in which the aorta was ossified, in a child aged three years, and other cases of an analogous character have been observed by ANDRAL. In one instance, he discovered several osseous plates occupying the aorta of a little girl of eight years old; and he observes, that in four or five subjects, between the ages of eighteen and twenty-four years, he had witnessed a similar transformation of the arteries. He likewise met with considerable ossification of the superior mesenteric artery of an individual aged about thirty years. (*Prècis d'Anat. Path.* II. 380.) In a female aged seventeen, OTTO discovered inceptive ossification of the aorta. (*Seltene Beobachtung.* Heft II. 66. No. xxix.) In other subjects, of not more than thirty years of age, he observed ossification of the cerebral arteries; and he subjoins, that this condition of the semilunar valves of the aorta, and of the ductus arteriosus, is not uncommon in young persons. (*Lehrbuch der Path. Anat.* I. 341.) For other examples of a similar character, he refers also to BÖHMER (*Obs. anat. rarior.* Fasc. 1. Præf. p. ix.), and PENADA (*Saggio di osservaz.* II. 22. Padova, 1800.)

It will be seen from these facts, that it is difficult to designate with certainty any particular age at which this transformation of the arterial tunics takes place. It seems to vary indeed in different countries. It is stated by LOBSTEIN, that in the neighbourhood of Strasbourg, not only ossification of the arteries, but also of the uterus, and thyroid gland, is often observed at the age of thirty. This is certainly earlier than it occurs in most other countries, in which it will seldom be observed before the age of fifty or sixty. Indeed, it has been represented as being comparatively rare in some climates. In the West Indies, STEVENS affirms that ossification of the arteries is by no means common (*Med. Chir. Transact.* V. 434.); and OTTO remarks that it is seldomer observed in Silesia than in some other quarters. (*Op. Cit.* p. 341.) He thinks that the free use of wine, cider, and strong alcoholic drinks, in France and England, may be the cause of its greater frequency in those countries. It has been supposed by many, that the rachitic and arthritic diatheses are fruitful sources of this osseous transformation, and by others it has been imputed to the influence of syphilis and mercury. It will be seen, however, that the agency of most of these causes is in no degree in relation with the effect—ossification of the arteries being, as previously stated, too common to derive its origin from either of these influences. By ANDRAL, especially, a gouty diathesis has been supposed to exercise an important agency in the development of this condition. Setting out upon the well-known tendency of this disease to give rise to calcareous concretions of the joints and to urinary calculi, and taking into account the facts established by MAGENDIE, that when carnivorous animals are fed upon aliment containing no azote, both uric acid and phosphate of lime disappear from the urine, he reasons, that the tendency of a too liberal indulgence in an aliment abounding with azote, as is the case with gouty persons, is to give rise to a preternatural generation of these materials, and their consequent deposit, either in form of urinary calculi, gouty concretions of the joints, or ossification of the arteries. According to this view of the subject, the first step in the morbid process is, a modification in the properties of the blood, and the deposit of earthy matter, and the other attendant phenomena are merely consecutive. The adoption of this hypothesis would necessarily give to the diathesis in question an almost universal influence, since, as has been already remarked, a large proportion of individuals in advanced life, are affected with ossification of the arteries. It is possible, however, that a too free indulgence in such a diet may give rise to changes of the kind alluded to, yet we are satisfied this may take place without any participation of a gouty diathesis, and merely as a consequence of modifications of nutrition and secretion, induced either by the quality or quantity of aliment, the

influence of climate, age, and other circumstances. CRELL, MORGAGNI, and others, long since referred these osseous productions to the influence of inflammation—a sentiment in which they were confirmed by the traces of redness and other characters of that process, with which they are sometimes associated. This opinion has been espoused by some modern pathologists, and especially by BROUSSAIS and RAYER. The chief arguments which have been adduced in its support have been drawn from the analogies furnished by other serous and fibrous tissues, in which it is alleged similar productions are not unfrequently found. The pleura, pericardium, dura mater, &c., are all occasionally the seat of the accidental development of plates of bone of variable magnitude, which it is usual to attribute to inflammation. Hence it is assumed that ossification of the arteries may be legitimately ascribed to similar changes excited in the serous and fibrous tunics of those vessels by inflammatory action. That the inference is true in some cases, it would be as difficult to disprove, as it would to demonstrate that it is so in all. Numerous facts clearly show, that under particular modifications of vital action, inflammation is capable of giving rise to a species of osseous transformation of several of the animal structures, and there is no reason to consider the tissues of the arteries as entirely exempt from these changes. Yet when we take into account the extreme frequency of ossification of these vessels, its constant tendency to occur in advanced life, when the liability to inflammation is very much diminished, and the total absence of all the phenomena of that process in a large proportion of cases, it is manifest, that it must, in a majority of instances at least, derive its origin from some other cause. What this cause is, it is difficult to explain. We may legitimately refer it to some modification of nutrition or secretion, yet this offers no explanation of the secret operations of vitality by which these changes are induced. The constant distension of the coats of the arteries, however, together with the modifications of their textures, and of the blood they circulate, which take place as age advances, are all circumstances which dispose them in a peculiar manner to become the seat of these adventitious deposits; and while most of the other tissues are rendered firm and rigid in advanced life, by the deposit of elements differing in kind from those which belong to them in earlier years, by analogous modifications of nutrition and secretion, the coats of the arteries under the same circumstances, become the seat of calcareous deposits. As to the redness and other appearances of inflammation which are occasionally observed in the vicinity of these osseous productions, they are generally altogether consecutive, and the redness not unfrequently consists in a small quantity of blood insinuated beneath the edges of the ruptured lining membrane of the artery.

How far these productions should be considered as identical with bone, is a question which is not yet satisfactorily decided. So far as their hardness, and their earthy constituents are concerned, they certainly possess a strong analogy with that structure. This is confirmed both by simple inspection and chemical analysis; for although the results obtained by different chemists vary somewhat, they all concur in showing that the osseous productions of the arteries contain some of the principal constituents of bone. Thus, according to the experiments of BRANDE, they are composed of phosphate of lime 65.5, animal matter, consisting of albumen with a few traces of gelatine 34.5. (HODGSON, p. 26.) VAUQUELIN obtained phosphate of lime 65.3, carbonate of lime 6.5, soluble salts 4.0, and animal matter 24.2. (RAYER. *Archives Générales*. I.) The analysis of LASSAIGNE furnished mucous animal matter 50, phosphate of lime $47\frac{1}{2}$, carbonate of lime 2, and some traces of sulphate of lime. The slight difference in these results indicates that the proportion of the component elements varies in different specimens; and a similar variation is observed in the composition of natural bone.

Those who have assumed the identity between these productions and natural bone, maintain, that coagulable lymph is first poured out by the inflamed tissues; that this is solidified, gradually converted into cartilage, and is finally, by the deposit of earthy matter, converted into bone, precisely as ossification takes place in the bones themselves. MORGAGNI supposed that the purulent matter which is sometimes deposited beneath the lining membrane is gradually transformed into these calcareous plates; and HALLER inferred that the atheromatous secretion is by degrees converted into a firm coriaceous or cartilaginous tissue, which by subsequent changes acquires the properties of bone. There is nothing to justify either of these inferences. Although calcareous deposits are occasionally found in the midst of a

portion of the arterial tunics of a cartilaginous consistence, they are much oftener met with without any such accompaniment; and notwithstanding earthy concretions are sometimes formed in the midst of a collection of atheromatous matter, such instances are so comparatively rare as to show that there is no necessary connexion or dependence between the two formations. The only analogy, indeed, between these calcareous productions and bone, consists in their chemical composition; for although they are both composed of phosphate and carbonate of lime, and animal matter, the adventitious productions present no traces of a fibrous or lamellated structure, but have a greater analogy with a rude crystal or petrifaction, the calcareous matter being deposited in the interstices of the natural structures, where it accumulates to such a degree in some cases as to completely supplant them.

The influence of these transformations upon the physiological acts of the organs is exceedingly difficult to estimate. It will vary, indeed, according to the vessels affected, and the extent of their implication. We shall have occasion under another head to notice the tendency of the calcareous masses to occasion narrowing and obstruction of the calibre of the arteries; and their agency in the production of ulceration and aneurism of these vessels has been already considered. How far this condition influences the circulation of the blood cannot be ascertained. Bichat affirmed that ossification of the aorta is capable of modifying this function, but that the same condition of the arterial trunks, branches, ramifications, &c., does not occasion the slightest derangement. (*Anat. Générale.* II. 66.) The latter part of the proposition is too palpably erroneous to require refutation. The influence of ossification of the arteries in producing apoplexy, epilepsy, palpitation of the heart, derangements of the pulse, coldness and inactivity of the extremities, gangrene, &c., is so well known, that we cannot doubt for a moment that when these vessels become extensively involved in this species of transformation, more or less disturbance of function must be the necessary consequence. It seems, indeed, that it may in extreme instances produce a complete annihilation of all pulsation. A case of this kind has been reported by Berryat. The subject of it was a female, in whom not the slightest indications of pulsation could be perceived, either in the vicinity of the heart, or any other part of the system, even after active exercise, and while the body was heated. (*Hist. de l'Acad. Roy. des Sc.* 1748. p. 61.)

But while these truths are incontestable, it must be confessed, that many aged persons affected with ossification of the arteries even to a great extent, experience no disturbance of function from that cause, and enjoy as good health as is usual at their period of life.

Tuberculous matter is probably seldom deposited in the tissues composing the arteries. In our numerous examinations we have never met with a single example, although we have repeatedly observed small masses of tuberculous degeneration adherent to the outer surface of these vessels. Sandifort, however, seems to have met with this affection (*Obs. Anat. Path.* Lib. IV. cap. x. p. 109., and *Mus. Anat.* I. 242. No. IX.), and Otto also affirms that he observed scrofulous tumours so intimately connected with the coats of the aorta and carotid artery, that they could not be isolated, except by dividing the external tunic. (*Lehrbuch der Path. Anat.* I. 343.)

Melanotic matter is likewise very rarely observed in the coats of the arteries. It is true that they are sometimes found affected with small dark-coloured points, which seem to occupy the space between the internal and middle tunics; but it is probable, as Bouillaud has remarked, that they are merely small masses of blood, which have been some time extravasated in the substance of the coats of the vessel. A case has nevertheless been delineated by Cruveilhier, in which, besides numerous masses of melanotic matter occupying different portions of the heart, one is seen implicating the coats of the pulmonary artery. (*Anatomie Pathologique de l'Homme.* Liv. XIX. plate 4.)

Cancerous degeneration, so far as we are aware, has only been found in a few instances in the arterial system. Of the cases to which we allude, one was observed by Velpeau, and has been quoted in the article *Aorta*, p. 163, and the others by Laennec. (*Auscult. Médiate.* II. 684.)

The various lesions which have been described in the course of these remarks, though included under the titles of acute and chronic arteritis, cannot with propriety be all referred to inflammation. Many of them unquestionably have that origin, yet there are several others, which seem to be owing to modifications of nutrition and secretion, in the production of which inflammation has no agency. What the precise modifications of vital action may be, by which such a diversity of consequences

is produced, cannot be satisfactorily ascertained, and in the absence of positive information, we must be satisfied to study the effects, until the advances of pathological science shall make us acquainted with those mysteries of vitality, which are at present shut out from our comprehension.

Symptoms and Diagnosis of Arteritis. The symptoms of acute inflammation of the arteries are so analogous to those common to many other affections, that it is not easy to discover any traits sufficiently constant and characteristic, to distinguish it from diseases of other portions of the organization. The difficulty is greatly augmented by the deep seat of some of the principal vessels, by the complex relations of all of them, and by their peculiar liability to have their functions thrown into disarray, by almost every disturbance affecting other tissues and organs. We shall first enumerate the principal symptoms that accompany the disease in its different stages and modifications, and afterwards consider how far any of them can be relied on in forming a diagnosis.

Acute inflammation occupying a small extent merely of a single artery, is often unattended with any very striking disturbance of either a local or general character. Thus, after the application of a ligature, which always occasions more or less inflammation of the vessel, there is often no very palpable alteration of the part: there is but little increase of sensibility, heat, or tumefaction, and the whole process of obliteration may be accomplished, without the supervention of any febrile or other constitutional disturbance. It is far different, however, when the inflammation is more extensively diffused, and when it seizes with considerable intensity upon a large extent of the arterial system. Under such circumstances, it is attended with violent fever of the inflammatory kind, the symptoms of which vary much in the progress of the disease. The modifications thus accruing, are partly attributable to the influence exerted upon the vital powers, and in part to changes taking place in the structures of the vessels themselves, and the blood they circulate. The first symptoms manifesting a general disturbance of the system, are commonly slight chills, alternating with flushes of heat, which are speedily followed by intense fever, attended with violent pulsations of the heart and arteries, a red suffusion with capillary injection of the skin, burning heat, unquenchable thirst, extreme restlessness, jactitation and general distress, laborious and hurried respiration, and sometimes a dry harassing cough. When the inflammation is seated in the aorta, there is, according to JOSEPH FRANK, a sense of heat beneath the sternum, or in the vicinity of its upper extremity; and SPANGENBERG and KREYSIG remark, that the patient sometimes complains of a sensation like that of hot iron drawn along the course of the aorta, descending as low as the crural arteries. When the arteries of the extremities are affected, there is pain, sometimes simulating rheumatism, sometimes of a burning kind, in the course of the inflamed vessel, which either fixes itself with considerable intensity upon a particular part, or is unequally diffused. The affected point is tender to the touch, and if the vessel be superficial, there is generally increased volume and hardness of its walls, perceptible through the integuments. There is likewise increased heat, and sometimes more or less tumefaction, with a distressing sense of throbbing. At first the pulsation is preternaturally violent along the whole extent of the inflamed artery, but in proportion as its tunics, and the blood within, become altered, the inordinate throbbing and expansion of the vessel is confined to the portion above the principal seat of the inflammation, while lower down the pulsation becomes feeble, and when obliteration takes place, finally ceases altogether. Should the carotid artery be affected, there will be pain and tenderness along the side of the neck, attended with violent pulsation in that region and in all the arteries of the head,—distressing cephalalgia, vertigo, flashes of light before the eyes or obscuration of vision, ringing or roaring in the ears, and in some cases violent delirium, convulsions, or even apoplexy. In one of FRANK's cases, the patient complained of everything wearing a green colour; and in most instances, whatever artery is affected, the corresponding veins and capillaries are preternaturally turgid in the first stage of the disease, owing to the blood being propelled into them with increased impetuosity.

From the first onset of the disease, the heart beats violently, and is affected with frequent palpitations, especially if the inflammation implicates its lining membrane. There are forcible pulsations or throbbings of the whole arterial system, and during the whole of the first stage, the pulse is full, strong, tumultuous, bounding, and sometimes exceedingly frequent. J. P. FRANK remarks, that it is in some

instances as tense and hard as a metal wire; and in one of the cases observed by him, its beats fluctuated from 185 to 200 in a minute. It also frequently intermits, or presents a kind of double stroke, and in some instances, if blood be drawn, both the hardness and frequency are increased. The respiration is hurried, embarrassed, and occasionally so difficult as to amount to distressing orthopnœa. There is also a troublesome dry cough, and sometimes hemoptysis; and if the disease be seated in the aorta, any sudden movement of the body occasions an increase of pain, and augments the general suffering. The tongue is red on the edges, its papillæ prominent, and its base and middle coated with a thick fur. The thirst is intense and unquenchable; the stomach sometimes irritable; the bowels constipated, and the urine high coloured, scanty, and voided with a sense of scalding. It is occasionally dark coloured, turbid, or even bloody. The face and eyes are suffused and turgid; blood occasionally flows from the nose; the injection of the capillaries occasions a preternatural turgescence of the skin and all the superficial vessels, and the surface sometimes assumes a deep red, purplish, or mottled appearance.

As the disease advances, the vital powers are gradually exhausted under its ravages; the coats of the inflamed arteries undergo important alterations; the blood sometimes becomes coagulated in the affected vessels; and with a general aggravation of most of the above symptoms, a new train of phenomena is frequently superadded. The general anxiety, restlessness, and distress, now increase. The pulse augments in frequency; becomes small, wiry, weak, irregular, and acquires a peculiar sharp thrill. The dyspnœa is more distressing. The heart is affected with frequent palpitations, and the slightest motion or exertion, or an erect posture, occasion vertigo or a disposition to syncope. The tongue is dry, scabrous, and covered with a brown sordes; the thirst is intense; the skin is covered with clammy sweats; the countenance assumes a sunken, decomposed or cadaverous expression, or it is lurid and œdematous; the bodily powers decline, and the patient is affected with delirium, especially at night, subsultus tendinum, or frequent convulsive movements of different parts of the body. The bowels, which are at first constipated, now assume an opposite condition, and the dejections are frequent, dark coloured, and highly offensive. The urine is also dark, turbid, and fœtid, and the whole of the secretions and excretions are perverted. The skin, which was at first simply injected, now assumes a deeper purplish hue, and if the inflammation occupy one of the principal arteries of the extremities, the condition of the affected parts undergoes important changes. The alterations of the textures of the vessel, and the formation of fibrinous concretions by the coagulation of the blood within, gradually interrupt the transit of that fluid, and the portion of the member situated below the seat of the disease, has its nutritive functions impaired in a corresponding degree. The preternatural pulsation, which at first was manifest along the whole course of the artery, is now only perceptible above the seat of the disease, while below it is feeble and indistinct. This arises from the gradual obliteration of the vessel, and is attended with a sense of coldness and numbness of the part, resulting from the privation of its nutritive fluid. The obstacle to the course of the blood thus created, occasions a distension of the artery above, with preternatural pulsation; and Naumann remarks, that in one case, it imparted the sensation, to the finger, of a distended membranous sac, having a fluid issuing from its surface by numerous pores. (*Handbuch der Med. Klinik.* II. 606.) Should the obliteration be complete, all pulsation below ceases; the limb becomes œdematous; the blood gradually accumulates in the radicles of the veins, giving rise to a dark ecchymosed appearance, arranged either in isolated points, or more diffused; the part becomes cold and numb; small purplish phlyctenæ make their appearance, and the part finally falls into gangrene, unless the collateral anastomoses should so far escape the disease, as to admit of their furnishing a sufficient supply of the vital fluid to obviate these consequences. With the development of these phenomena, the powers of life become more prostrated; the pulse more frequent, small, sharp, and irregular; the clammy sweats more profuse; the delirium gives place to a profound coma; the evacuations come away involuntarily; hiccup supervenes; the extremities grow cold, and the patient either sinks exhausted, or death is ushered in by convulsions.

When the disease takes a more favourable course, it is represented by Puchelt, that it sometimes pursues a regular progress until the seventh day, exacerbating twice in the twenty-four hours, and then forms a crisis, either by a free perspiration, hemorrhage, or the deposit of a co-

pious sediment in the urine. (*System der Medicin.* Band II. II. Th. 63.)

Complications. These may be regarded as the ordinary phenomena of acute inflammation of the arteries. But in some instances it presents complications which deserve a passing notice. Several conditions have been spoken of by authors, either as accompaniments or consequences of the disease, and it becomes an important question to decide, how far they can be properly regarded as such. Of these, the following may be noticed:

1. *Erysipelatous inflammation of the arteries.* Whether inflammation of the arteries arising from common causes, and independent of injury inflicted upon these vessels, ever assumes the erysipelatous character, we have had no opportunity to decide. We are convinced that such an occurrence must be rare, since it has scarcely been noticed by those who have possessed the most extensive means of observation. Still it would be improper from this to infer its non-existence; for some examples apparently well authenticated have been reported, and it perhaps would be oftener observed, but for the difficulty of discriminating between it and simple inflammation, especially when the surrounding parts do not become extensively involved in the disease. Amongst other examples of idiopathic erysipelatous inflammation of the arteries, we may refer to one reported by HANKEL, in which the ascending portion of the aorta and the arch were involved to a considerable extent. (RUST's *Magazin für die Gesammte Heilkunde.* XXXIX. 234. 1833.) The subject of the case was a stout man, aged 30, descended of parents who had been subject to gout and erysipelas. The most prominent symptoms during life were, extreme difficulty of breathing, and agonizing pain beneath the sternum, which was considered rheumatic. Erysipelatous inflammation of the arteries following the application of ligatures and other injuries is probably of less rare occurrence. GUTHRIE seems to think, that whenever inflammation is excited by this cause, and spreads along the internal coat of an artery until it reaches the heart, it is of the erysipelatous character, and is a most fatal disease. He subjoins, that he had only verified its existence by dissection in three instances; and in all, the patients died very quickly after the accession of the symptoms; but that others have noticed in their post-mortem examinations, inflammation extending from the spot where a ligature had been applied, up to the heart, and in these cases, death was preceded by symptoms of low and irritable fever. (*Diseases and injuries of the arteries.* p. 20.) In one of the three cases, the subject of which died suddenly and unexpectedly, the limb was greatly swelled and gorged with blood; the femoral artery, when opened, appeared more vascular than is commonly observed; its internal membrane was very red, and easily separated from the middle coat, and the fluid which lubricated its surface was of a more serous nature than usual, and greater in quantity. In each of the other cases, the right leg and thigh were greatly swelled and œdematous; the skin was of a pale dead-white colour; the countenance extremely anxious and bedewed with sweat; the pulse 140 and weak, and the patient sensible. The arteries showed the same characters as in the other, and the disease extended upwards as high as the diaphragm. He represents, that the symptoms which mark this state of disease, when distinguishable, are a very quick pulse, a rapid deterioration of the state of the patient, and degeneration into irritative fever, with low delirium followed by death. (*Ibid.* p. 21.)

How far these characters justify the distinction attempted to be established, we will not positively affirm. In a case to which we have alluded above, in which death was rapidly induced by inflammation spreading along the brachial artery to the heart, from a ligature which had been applied after amputation of the arm, most of the symptoms enumerated by GUTHRIE were present; yet it will be seen that they are also contained in the category of phenomena pertaining to common inflammation of the arteries.

2. *Inflammatory and Ataxic Fever.* The hypothesis of the association of violent inflammatory fevers with inflammation of the arteries, was first promulgated by J. P. FRANK. It afterwards gained many advocates, and is still believed by some respectable pathologists, especially in Germany. REIL seems to think that while inflammation is a local affection of the vessels, inflammatory fever is a general phlogosis of the tunics of the whole vascular system; and after remarking, that when violent fevers of this kind are trusted to nature, they give rise to a generation of purulent matter in the arteries, which, if not too large in quantity, is thrown off by the ordinary emunctories, as the kidneys, &c., he asks the question, whether the blood is under such circumstances metamorphosed into pus, or that

matter is the product of the inflamed vessels. (*Ueber die Erkentniss und Cur der Fieber.* II. 305.) Not to mention Pinel, Joseph Frank, Hildenbrand, Raimann, Wedekind, Berends, Puchelt, and many others, who have adopted similar, if not identical views, we may remark, that by Bouillaud, inflammatory fever is declared to be nothing more than a general irritation of the sanguiferous system, which does not differ from inflammation proper. (*Traité des fièvres essentielles.* p. 19. Paris, 1826.) In corroboration of this opinion, he represents that he found redness of the lining membrane of the heart, eleven, and of the vessels, eight times, in forty-nine examinations of persons dead of fever. Louis observed unusual redness of the lining membrane of the heart, three times in fifty-four subjects, and the same condition of the aorta in twenty cases out of the same number; but Andral only found this redness six times in eighty-six fever subjects.

It will thus be seen, that evidences of inflammation of the arteries in those who have died of fever, is far from being constant, and that the chief necropsic character of this inflammation discovered in the cases alluded to was, a preternatural redness of the lining membrane of the vascular system. If then we recall to mind the remarks already made in reference to the nature of this redness, under the head *Aorta*, and in the first part of the present article, the inference will be irresistible, that the anatomical characters of fever do not support that hypothesis which makes its essential character consist in a state of inflammation of the sanguiferous vessels in general, and of the arteries in particular. The arteries, it is true, in common with the other tissues of the body, may become involved in inflammation in some cases of fever. Yet such implication seems rather to be an accidental consequence of the preternatural stimulation of the vascular system, excited by the affection of other organs, and by changes taking place in the properties of the blood during the progress of the disease, than a primitive and necessary element of the fever itself. Hence, it is oftener observed in fevers of a malignant or ataxic character, than in those which are less protracted, and in which alterations of the blood are consequently less considerable. The deterioration of the blood, moreover, which takes place in malignant fevers, in smallpox, scarlatina, &c., together with the corresponding impairment of the cohesiveness of the solids, are precisely the conditions in which the red tinting of the vessels from imbibition is most apt to occur. Inasmuch, therefore, as it has been proved satisfactorily, that in a large proportion of cases, redness of the lining membrane of the heart and arteries is not inflammatory, we should be cautious not to attach too much importance to it, when we find it existing as a concomitant of fever, either inflammatory or ataxic. Nor does the violent action of the heart and arteries—the strong, full, and bounding pulse, and the active commotion of the vascular system, which form such conspicuous phenomena at the outset of these forms of fever, necessarily indicate that the arteries are inflamed. They are inordinately stimulated by the sympathetic influence transmitted to them from other organs similarly affected—by the blood too richly charged with fibrine, albumen, &c., or by various deteriorations developed in the properties of that fluid, under the influence of impaired or perverted innervation, by which it acquires properties detrimental to the vessels which circulate it. Thus far then, the arteries are involved in febrile affections: they feel their influence in common with other tissues and organs, but there are no facts to justify the inference that any one of the various forms of fever depends primarily and essentially on inflammation of these vessels. There is often a preternatural pulsation of the heart and arteries observed during convalescence from protracted fevers, which has by some been regarded as an indication of inflammation of the lining membrane of the vascular system. We will not assert that it may not sometimes depend upon this cause; yet in a majority of instances, we are satisfied from a close attention to the subject, that it is owing to a simple state of neuropathy of the heart and arteries, which, instead of being relieved by antiphlogistics, is often exasperated by such remedies. It is analogous to the condition produced by excessive abstractions of blood, and requires for its removal an analogous treatment. We have within a few days effectually relieved an individual recovering from a protracted attack of fever, in whom this condition of the vascular system existed to a distressing degree, by large doses of carbonate of iron suspended in wine.

It has been mentioned above, on the authority of Reil, that in the course of inflammatory fevers, purulent matter is generated in the blood-vessels, either by changes taking place in the blood itself, or by a secretory process of the inflamed

coats of the arteries, and that the lateritious sediment found in the urine is composed of this matter thrown off by the kidneys. This opinion is also adopted by Langenbeck (*Nosologie und Therapie der Chirurgischen Krankheiten.* I. 588.); and Treviranus suggests that the crisis of fevers is probably formed by the generation of purulent matter in the entire mass of blood, which is so modified in the act of being thrown off by the emunctories, that it cannot be recognized as such in the secretions and excretions. (*Biologie.* V. 417.) This hypothesis, if well founded, would go to corroborate the doctrine that many fevers and febrile affections are dependent on inflammation of the arteries. But as the predicate is unfounded, the inference cannot be valid. There is in the first place, no evidence of the generation of purulent matter in the blood as a common result, and instead of the copious sediment thrown down by the urine being any proof of the fact, it can be easily shown to be dependent on another condition. It is well known, that under any preternatural excitation of the heart and arteries continued for some time, the blood becomes much richer in fibrine and albumen than it is in health. So soon, therefore, as the excessive action is subdued, or in other words, the disease terminates by crisis, these fibrinous and albuminous materials are reduced to their natural standard as regards quantity; and the redundancy of the latter being thrown off by the secretions, it manifests itself in the urine, in form of a copious lateritious sediment, which is composed of albumen, blended with various salts which pertain to that fluid.

3. *Spontaneous gangrene.* We have observed, in treating of the anatomical characters of acute arteritis, that when it attacks the vessels of the extremities, it very often terminates in gangrene. From this circumstance, it has been alleged by respectable pathologists, that spontaneous gangrene very generally depends upon inflammation of the arteries, terminating in obliteration of their calibre, and a consequent obstruction of the course of the blood through the limb. When it is proved that the effects of inflammation are to occasion a deposition of coagulable lymph by the internal membrane, coagulation of the blood within, and a consequent obliteration of the vessel, it follows of necessity, that gangrene must be the result, except the collateral circulation should be sufficient to compensate for the interruption of the course of the blood through the main arteries of the member. In this respect, therefore, it must be admitted, that inflammation of the arteries is a cause of gangrene—not directly, in virtue of any peculiarity it may possess, but indirectly, by cutting off the supply of blood which is necessary for the nutrition and preservation of the part. Hence the obstruction of the main vessels by fibrinous concretions, which is found under such circumstances, is not a consequence of the mortification, but the cause, and these concretions only produce their effect, like any other mechanical obstruction, as extensive ossification of these vessels, and various other morbid products, which are sometimes observed to occasion results precisely similar. Arteritis should not, therefore, be regarded as the sole cause of spontaneous gangrene, but only as one amongst many others, capable of exercising a similar influence upon the circulation of the part affected. (See *Mortification.*)

After all these remarks, it must be apparent, that in the present state of our knowledge it is exceedingly difficult to point out any characters upon which a certain reliance can be placed in forming a diagnosis of acute arteritis. When the aorta and other large arteries, which are deep-seated, are affected, the symptoms which seem to be entitled to most confidence are, an augmented activity of the pulsations of that vessel, and sometimes of the whole arterial system; a sense of heat, pain, or uneasiness, following the course of the affected vessel; a feeling of great anxiety, and a disposition to syncope, such as occurs in many affections of the heart. In the abdominal aorta, when this preternatural pulsation and the other symptoms exist, if great tenderness should be observed on pressure, the reason for suspecting inflammation will be still stronger. If in addition to these indications, there should be violent throbbing of the whole arterial system, general turgescence of the veins, together with great injection of the capillary vessels of the skin, there will be a strong presumption of the existence of extensively diffused arteritis, provided no evidences of pericarditis, aneurism, or hypertrophy of the left ventricle of the heart, be discovered. When the inflammation affects a single vessel, and especially one that is superficial, it may generally be discovered by the following symptoms:—a sense of heat, tenderness, or pain, following the course of the vessel; a strong, peculiar, vibratory or purring pulsation, more forcible above than

below; a sensible thickening, induration, and enlargement of the vessel; and in the last stage of the disease, paleness, numbness, and coldness of the portion of the member below the seat of the inflammation. If, at this juncture, the pulsation should be found strong and purring above, and feeble or entirely extinct below, with an œdematous condition of the limb, ecchymosis, phlyctenæ, or vesications of the skin, manifesting a tendency to gangrene, there can be little reason to doubt the nature of the disease, and that it has already occasioned obliteration of the vessels. Still, it should be remarked, that most of these symptoms may be observed in other affections, and that great circumspection should be observed in forming a conclusion from any of them.

The symptoms of chronic arteritis are so diversified, according to the changes of structure and capacity developed in the affected vessel, that it would be needless to attempt to enumerate them. In many cases, this form of the disease occasions very little functional disturbance, and when it has proceeded so far as to give rise to extensive transformations of the coats of the vessels, it generally becomes so far blended with other diseases, as to render it impossible to discriminate between them.

Causes of acute inflammation of the arteries. Acute arteritis may be produced by any of the ordinary causes of inflammation. Yet it is a remarkable fact, that the whole of the surrounding parts sometimes slough away, and leave the arteries bare and exposed, without their coats participating in the disease. They are likewise found traversing gangrenous parts, large abscesses, masses of encephaloid or cancerous matter, and parts which are intensely inflamed, preserving the perfect integrity of their structure throughout the whole progress of those diseases. This immunity, however, does not always exist, and they accordingly sometimes take on inflammation, either from causes acting directly on them, or exercising their influence through the general system. In regard to sex as a predisposing cause of the disease, it has been observed, that males are more liable to it than females. A gouty and rheumatic diathesis has been supposed to predispose in a peculiar manner to inflammation of the arteries, and it has been observed, that those who are remarkable for their liability to erysipelas, often suffer from this disease. It may also be produced by sudden exposure to cold or wet when the body is preternaturally heated, by violent passions and emotions of the mind, inordinate bodily fatigue or exertion, a too free indulgence in articles of diet calculated to increase the crasis and stimulating properties of the blood, the immoderate use of vinous and alcoholic potations—in short, whatever tends to keep up a preternatural excitement of the heart and arteries. Hence, as we have previously remarked, it is sometimes a concomitant of inflammatory and other fevers. Breschet observed several cases in which it was excited by erysipelas, and Copland found the arteries inflamed in two cases of puerperal fever. It may also be induced by repelled eruptions, by the absorption of purulent or other irritating matters—the abuse of mercury, protracted or badly-managed syphilis, the introduction of poisons into the circulation, or the excessive use of acid drinks. It is probable that when it takes place in the advanced stage of malignant or ataxic fever, the direct cause of its development is the generation of some irritating property in the blood, which exercises a deleterious influence upon the surface of the vessels in contact with which it circulates; and the same is doubtless true in some of the more violent exanthematous affections. Other causes are purely traumatic. They are, preternatural distension or elongation of an artery, as in dislocations; incised, punctured, contused, and lacerated wounds affecting these vessels; long-continued pressure, the influence of surgical operations, the application of cauteries, and the action of ligatures when applied for the purpose of arresting hemorrhage or the cure of aneurism. Notwithstanding the slight disposition of the arteries to take on inflammation when tied, a character in which they differ remarkably from veins, the influence of the ligature upon them is occasionally productive of serious consequences. We have already alluded to a case in which violent inflammation of the brachial artery was excited by a ligature applied after amputation, and occasioned death by spreading to the heart and pericardium. The arch of the aorta was found intensely inflamed, and lined by a pulpy pseudo-membrane; the pericardium filled with a turbid sero-albuminous fluid, and the heart so softened that its texture could be broken up under very slight force. Hodgson reports a case in which inflammation extended from the femoral artery to the heart, after the application of a ligature to that vessel, and occasioned death: a similar occurrence was observed by

CLINE and ABERNETHY; and LANGENBECK states, that in one instance in which he amputated the leg, the vessel became highly inflamed as high as POUPART'S ligament, and was found filled with purulent matter. The same condition was observed by EVANS, in the axillary and brachial arteries, after the application of a ligature to the carotid for the cure of an aneurism of the innominata; and OEHME has reported a case, in which the hypogastric arteries were affected with inflammation in consequence of the application of a ligature to the umbilical chord. Examples of the transfer of inflammation from wounds of the neighbouring parts to the large arteries are so common, that it is not necessary to specify them.

Treatment of acute inflammation of the arteries. Much need not be said on the treatment of acute inflammation of the arteries. It must be varied according to the stage of the disease, its intensity, and the complications with which it is associated. In the active or sthenic forms of the disease, especially when the arterial system is extensively involved, the free abstraction of blood presents itself as the chief remedy, and it must be pushed to an extent commensurate with the exigencies of the case, and the powers of the system to bear it. Blood must be freely abstracted from the arm, and the operation repeated as often as the necessity may recur, provided circumstances should not arise to render such copious depletion improper. Local depletion will also be found highly serviceable, especially when the affected vessel is superficial. Leeches should be freely applied along the course of the inflamed artery, and the bleeding encouraged by fomentations with warm water. Should one application not be sufficient, they must be repeated at proper intervals, until a sufficient effect is produced. It was remarked by FRANK and SPANGENBERG, that the abstraction of blood rendered the pulse harder and more tense. This has been regarded by some practitioners as a sufficient reason for not resorting to the practice. But when the indications of active inflammation are unequivocal, bleeding is indispensable, and if the disease should be associated with a neuropathic disposition of the vessels, disposing them after venesection to take on this peculiar kind of reaction, when sufficient blood has been detracted, it may be useful, with the view to prevent the bad effects of this nervous erethism, to prescribe an opiate, either alone, or what will be preferable, combined with antimony and calomel, as recommended by COPLAND. But in resorting to the abstraction of blood, it must be borne in mind, that there are not unfrequently circumstances in the course of this disease, which will render it unsafe to push general bleeding to a great extent. There is frequently much proneness to syncope even after a slight bleeding, and the inflammation of the arteries is besides only developed in many instances, during the last stage of inflammatory and ataxic fevers, small-pox, scarlatina, puerperal fever, &c., when the powers of life are so prostrated, that the withdrawal of even a small quantity of the vital fluid might be productive of fatal consequences. Still, when there is great tenderness in the course of an artery, especially if the vessel be superficial, it may be necessary in some instances, even under these circumstances, to apply a few leeches along the course of the vessel—acting upon the same principles that guide us in the treatment of other local inflammations, attended with impairment of the vital powers.

Simultaneously with the abstraction of blood, the patient should be put upon the use of mild saline cathartics, either alone or alternated with calomel;—nitrate of potash, antimonials, mild diluent, subacid drinks, cathartic enemata, and, when preternatural throbbings of the arteries and palpitations of the heart follow the abstraction of blood, large doses of opium, black drop, or hyoscyamus, may be given in combination with calomel and antimony, to which when the powers of life are considerably prostrated, camphor may be added. Mercury, pushed to the extent of producing slight soreness of the mouth, has been recommended by HOPE, BERNDT, and COPLAND. But from the tendency of this article to occasion preternatural excitement of the heart and arteries, when administered so as to produce its constitutional effects, we should be reluctant to employ it in that manner, except in those cases in which the arteritis is induced by syphilis. After sufficient depletion, HILDENBRAND recommends the acetate of lead and digitalis, and from the power possessed by both of these agents in moderating the activity of the circulation, we doubt not they may be sometimes useful when employed with proper discrimination. Neither of them should be relied on to the exclusion of more important means, nor will they be proper in the very advanced stage of the disease when typhoid symptoms have made their appearance. Colchicum has also been suggested by

Copland; and when the intensity of the inflammation is considerably subdued, leaving a preternatural throbbing of the arteries, which is dependent on a state of morbid nervous erethism of those vessels, prussic acid might perhaps be employed with advantage.

When the disease occupies a superficial artery, as for example, in the extremities, the neck, &c., after sufficient blood has been detracted by leeches, the part may be constantly covered with refrigerant anodyne lotions, or if these should disagree, tepid ablutions may be employed with advantage. In addition to these applications, Berndt recommends, after the inflammation has lost its active character, the employment of warm moderately exciting aromatic fomentations, lotions of muriate of ammonia dissolved in vinegar and water, and frictions with mercurial ointment. (Rust's *Handb. der Chirurgie.* II. 298.) Under the same circumstances, a blister applied over the part, so efficacious in some cases of phlebitis, might possibly produce a good effect. Revulsives will also be useful in the advanced stages of inflammation of the large arteries of the splanchnic cavities. (See *Aorta.*)

The various complications of the disease with the several forms of fever,—with erysipelas, gangrene, &c., must be managed upon the general principles proper to be observed in the treatment of those diseases. As these complications are seldom observed, except when the vital powers have become considerably prostrated, blood-letting to any considerable extent will seldom be admissible, and the chief reliance must be placed upon mild antiphlogistics, and those means which, by exciting the several emunctories to the performance of their proper functions, will tend to separate from the mass of the circulating fluids, those materials which are generated in the blood, and tend to irritate the vessels. When obliteration of the arteries has taken place, giving rise to gangrene, the case must be managed according to the rules laid down in the article *Mortification.*

It is scarcely necessary to subjoin, that during the whole treatment, perfect quietude of both body and mind should be rigorously enjoined. The patient should be strictly confined to a light farinaceous diet, with iced, or cool demulcent drinks; and even during convalescence it will be necessary to restrict him from all animal food for a considerable time. Every source of irritation, both physical and mental, must, in short, be carefully avoided, since the heart and arteries are preternaturally susceptible, and owing to their intimate sympathies with the other organs, they will be seriously influenced by an active impression made upon any part of the system.

The *treatment of chronic inflammation* of the arteries may be dismissed in a few words. As the disturbance it occasions is seldom observed until the disease has advanced so far as to occasion extensive transformation of the arterial tissues, its existence is not known while it is in a condition to be cured. When these transformations of texture have taken place, it is beyond the reach of our remedies, and all that can be done is to obviate or remove the inconveniences they may occasion. They are chiefly such as arise from impaired circulation, and when they give rise to congestions of the left side of the heart, or of other organs, these must be removed by repeated small abstractions of blood, mild aperients, a proper attention to diet, and an avoidance of the ordinary sources of irritation. In some cases, when there is a loss of tonicity, unattended with serious changes of structure, chalybeates, and other tonics, with the shower-bath, may be useful.

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Rigot et Trousseau. *Recherches nécrologiques sur quelques altérations que subissent, après la mort, les vaisseaux sanguins, les poumons, et la membrane muqueuse gastro-pulmonaire, à l'état sain.* Arch. Gén. XII. 169. XIII. 461. Paris, 1826. XIV. 321. 1827.
Bouley. *Journal de Médecine Vétérinaire,* par Girard. Janv. 1827.

§ 2. *Dilatation of the arteries.* (*Arterieсktasis, Angiectasis, Telangiecktasis.*) In consequence of the almost incessant distending influence to which the arteries are exposed in the performance of their office, they often become preternaturally dilated, either at one or more points of limited extent, or throughout a considerable portion of their distribution. This dilatation assumes different forms according to the extent of the vessel affected, and the degree of the distension. It is also varied in its appearance by the size of the artery involved, and sometimes presents a different aspect when it affects the arterial ramifications and their anastomosing branches, from that which it exhibits in the primitive and secondary trunks. All these modifications, however, whatever their situation and extent, may be reduced to five primitive forms. Four of these have been enumerated by Breschet, as follows:

1. True sacciform aneurism (*aneurisma vera sacciforme*);
2. True fusiform aneurism (*aneurisma vera fusiforme*);
3. True cylindroid aneurism (*aneurisma vera cylindroideum*); which he subdivides according as it affects the large arteries, or their small ramifications,—including under the latter the aneurism by anastomosis of John Bell, or the erectile tumours of Dupuytren.
4. Cyrsoid aneurism (*aneurisma cyrsoideum*), arterial varix (*varix arterialis*) of Dupuytren. (*Mémoires chirurgicaux sur différentes éspèces d'Anévrismes;* par G. Breschet. p. 12. Paris, 1834.)

This arrangement we shall adopt, with the following modifications. We shall reject the term aneurism, as not being applicable to the modification of the arteries which we wish to consider, and substitute the word dilatation. And the third variety we shall divide into two,—the first including the proper cylindroid dilatation of the larger arteries, while under the second we shall include, as a separate division, the pathological state of the minute vessels, described by John Bell under the appellation of aneurism by anastomosis,—and denominated erectile tumour by Dupuytren, hæmatonca by Alibert, and telangiecktasy by Von Graefe.

Scarpa was the first to expose the impropriety of applying the term aneurism to a simple dilatation of the arteries; but he was not justified in asserting, that in all cases of that disease, there is a solution of continuity of one or more of the coats of the vessel. He affirmed, that the condition usually denominated true aneurism never exists, and that although the coats of an artery may be dilated, so as to form a tumour of considerable magnitude, it never exhibits the characters proper to an aneurismal tumour. Subsequent observations have clearly proved that this assertion is too exclusive. A considerable number of well authenticated examples of aneurism formed by the dilatation of all the coats of an artery, and having the ordinary lamellated fibrinous concretions within, have been reported; and although simple dilatation is much more common, the doctrine of Scarpa relative to this point, cannot be sustained. These considerations have led to attempts to draw a line of distinction between the characters of the condition properly denominated true aneurism, and that in which the coats of an artery are simply dilated, without presenting any of the other phenomena peculiar to aneurismal tumours. In simple dilatation, there are no fibrinous concretions formed within the vessel. The blood continues to circulate in immediate contact with the lining membrane, there being no obstacle to its course, except so far as it may be impeded by the increased calibre of the artery. In true aneurism, on the contrary, the whole internal surface of the dilated vessel is lined with fibrinous concretions, variable as to their consistence, disposed in a concentric series of layers, the most external of which adheres to the internal surface of the artery. (See *Aneurism.*) It should be remarked, nevertheless, that in some cases of great dilatation, small cracks and fissures occasionally form in the lining membrane, which entangle the blood, and occasion the development of a thin soft layer of coagulum, or the same effect may be produced by the roughness of that tunic occasioned by inflammation, or by the formation of albuminous deposits upon the inner surface of the diseased artery. These concretions, however, are seldom very considerable, except when the coats of the vessel are extensively ulcerated or ossified: they but rarely exhibit a lamellated arrangement, and as Guthrie has correctly remarked, they have more the appearance of accidental irregular formations, than of deposits in concentric layers.

1. *Sacciform dilatation.* In this variety of the disease, some portion of the circumference of the artery, generally of small extent, exhibits a small sac-like projection, formed by the dilatation of all the tunics. The size of these sac-like expansions varies, some of them not being larger than a pea, while others equal the volume of a half section of an egg divided longitudinally. In the inceptive stage of their formation, they are so slightly elevated above the level of the adjacent portion of the vessel as to be scarcely perceptible, and frequently they are not more conspicuous than the slight bulgings denominated sinuses of the aorta, which exist as a natural condition at the root of that vessel. When they attain a greater size, they form considerable prominences standing off from one side of the vessel; and in a few instances, we have seen several of them occupying different portions of the aorta, and giving it an irregular appearance. The dilated tunics of the artery are sometimes attenuated, but occasionally the fibrous and cellular coats become hypertrophied in proportion as the expansion takes place. Inasmuch, however, as these structures are less extensible than the cellular coat, they are not

susceptible of a very great degree of dilatation, but are apt to yield under the influence of the distending force to which they are exposed, and thus lay the foundation of aneurism. This, indeed, is the natural tendency of all extraordinary dilatations of the arteries. The causes which give rise to this condition, are apt to occasion more or less fragility of tissue, or produce cracks, ulcerations, atheromatous or calcareous deposits, which, when the distension has reached a certain point, destroy the lining membrane, and give origin to an aneurism, the progress of which is retarded at first by the fibrous coat. These changes take place as well when the sacciform dilatation exists alone, as when it is associated with the fusiform and cylindroid varieties of the disease. Indeed it frequently happens, that a portion of the ascending aorta is affected with fusiform dilatation to a considerable extent, and retains that character until the distension has reached a certain point, when, owing to the causes mentioned, a particular point of the vessel becomes weaker than the rest, the tunics in that situation take on the sacciform dilatation, and the lining membrane either remains, or is destroyed,—the bottom of the cavity in this latter case being formed by the fibrous coat. An instance of this kind has been delineated by Meckel. The ascending portion, and the arch of the aorta, presented a very large fusiform dilatation, and appended to this, a little above the origin of the vessel, there was a small sac-like projection, in the bottom of which the lining membrane was destroyed, leaving the fibrous coat entire. (*Tab. Anat. Path.* Fasc. II. tab. xv. Lips. 1820.) In such instances, should the disease advance, the fibrous tunic finally gives way, the cellular coat becomes greatly distended, and the disease assumes all the characters of aneurism.

Sacciform dilatation occurs most frequently in the ascending and thoracic portions, and the arch of the aorta. It may take place, however, in the carotids, the subclavian, the iliacs, or the larger arteries of the extremities. In some rare instances, indeed, it occupies all the principal arteries of the body. A very interesting example of this kind has been reported by Jules Cloquet. (*Surgical Pathology.* Translated by J. W. Garlick and W. C. Copperthwaite. 105 Pl. II. London, 1832.) The whole of the arteries were covered with aneurismal tumours (dilatations), varying in size from a hemp-seed, to a large pea. Some were found upon the aorta, and its principal divisions; but these were less prominent and fewer in number than those upon the arteries of the extremities. The axillary, brachial, radial, cubital, femoral, popliteal, tibial, and peroneal arteries, formed, in many parts of their extent, strings of knots, so numerous and closely situated were these tumours: those of the lower extremities, perhaps the least numerous, might without exaggeration be estimated at several hundreds. The arterial coats, of a whitish colour, did not appear altered in their structure, except in the situation of the tumours, where they were dilated and thin. In none of these tumours was any rupture of the internal or middle coat observed; nor in any of the arteries, was there ossification or steatomatous degenerescence. The dilatations were also found upon the small arteries, but not so distinct as upon the larger. Analogous to this is a case observed by Pelletan, who found sixty-three aneurisms (*dilatations?*) in the arterial system of one individual. The tumours varied in size from a filbert to an egg. (*Clinique Chirurgicale.* II. 1.)

2. *Fusiform dilatation.* This is by far the most common variety of dilatation. It occupies the whole circumference of the artery, while in the preceding form of the disease, the chief distension takes place on one side. In this species of dilatation, the portion of the vessel which presents the maximum of distension occupies the centre of the tumour, whence it tapers gradually above and below, until it loses itself in the natural calibre of the artery. A greater extent of the vessel is always affected in this, than in the preceding variety of the disease, and owing to the termination in the healthy portion of the artery being less abrupt, the dilatation may attain a great magnitude without the formation within its cavity of any lamellated coagula. The tunics of the artery are generally very much thickened, owing to modifications of nutrition taking place during the process of dilatation, and when it gives rise to aneurism, or to the formation of lamellated concretions, it is generally owing either to a destruction of the internal and middle coat at some point weaker than the rest, to the formation of cracks and fissures in the lining membrane, or the coexistence of atheromatous or calcareous deposits.

Fusiform dilatation may take place in any of the arteries, but it is much more common in the aorta, and especially its ascending portion, than in any of the primary, secondary, or ternary divisions. We

have already adduced numerous examples of this species of dilatation of the aorta, in treating of the pathology of that vessel, and we may now remark, that in the valuable cabinet of the University of Maryland, which contains the rich collection formerly belonging to Allen Burns, there are a number of specimens representing this dilatation in all the intermediate grades between its first inception, and its termination in aneurism. In one of them, the coats of the arch of the vessel are so much hypertrophied, as to measure nearly a quarter of an inch in thickness. In the same collection there is also an example of fusiform dilatation of the femoral artery, directly beneath Poupart's ligament. Breschet has figured a case in which the portion of the internal carotid, which is lodged in the cavernous sinus, was affected with this condition: also one, having, besides a large fusiform dilatation of the ascending aorta, several of small size occupying the common and external iliac arteries. (*Op. Cit.* Pl. III. p. 25.)

3. *Cylindroid dilatation.* In this variety of the disease, the dilatation not only occupies the entire circumference of the vessel, but also reaches along it to the extent of several inches, or even to a greater distance. In this latter particular it differs from the fusiform dilatation. The artery is very greatly augmented in size, but still retains its cylindrical form, except in the vicinity of the point at which the dilatation terminates, where it tapers gradually, until the distended portion loses itself in the natural calibre of the vessel. The coats are generally very much attenuated, so that if the dilatation be considerable, the vessel is flaccid and collapses like a vein. In some instances, nevertheless, there is more or less thickening, especially at some points; but this condition is less frequently observed in this, than in the cirsoid dilatation. It is besides not unusual for the vessel to be unequally distended at different points, and to present an irregular surface. These inequalities may indeed be so great, as to give rise to an association of the sacciform with the cylindroid dilatation. At the same time that the artery is increased in diameter, it often becomes more or less elongated; but this seldom takes place to so great an extent, as to occasion those sudden and nodulated flexures which exist in arteries affected with varix. A case has been reported by W. Hunter, in which the thoracic aorta was enormously dilated, and at the same time so much elongated, that it formed numerous flexures between the summit of the chest and where it glides between the pillars of the diaphragm (*Med. Observations and Inquiries.* I. 323); and Bertin and Bouillaud assert, that this vessel is occasionally so much altered in size and configuration as to resemble the colon. Dilatation of the pulmonary artery is rare; yet Lobstein has reported the case of an individual, aged thirty-four, affected with dropsy of the pericardium, in whom this vessel measured two inches in diameter, and the branches, as far as their second divisions, presented a proportionate dilatation. (*Traité d'Anat. Path.* II. 534.)

This form of dilatation is not, however, confined to the aorta: it may affect any part or even the whole of the principal arteries or their larger ramifications. Breschet, indeed, has included under this head, aneurism by anastomosis; but we prefer to consider that condition as constituting a distinct variety of dilatation. We had under our care a few years ago, an individual aged about fifty, who after suffering for a long time from repeated and violent attacks of vertigo, which could only be relieved by small abstractions of blood, became dropsical, and finally died of great prostration. Nearly the whole of the arteries, from the aorta even to the small ramifications, were found dilated to at least twice their natural size, and many of them in a still greater degree. The superficial temporal branches were almost as large as the brachial artery of a healthy subject, and were so tortuous, that they almost assumed a proper varicose condition. The dilatation was also very great in the principal arteries of the brain; and Breschet remarks that he had several times encountered this condition in the basilar artery, in the carotid where it is embedded in the cavernous sinus, the occipital, temporal, auricular, the posterior tibial, and other arteries of the upper and lower extremities, and in those of the splanchnic cavities.

So far as the arterial ramifications are concerned, some of them are liable, at particular periods of life, to a certain degree of dilatation which is entirely physiological. This takes place in the uterine arteries during gestation, and the same thing is observed in many other organs when their activity is greatly increased. A temporary dilatation also takes place in all preternatural congestions; but these subjects do not properly fall within the scope of our present observations. The physiological dilatations, however, which are developed in the collateral branches

after the obliteration of the main artery of a part, may be adverted to, and we may besides remark, that it frequently happens when the principal vessel leading to an organ is obstructed, or narrowed, from any cause, the others become preternaturally dilated, to compensate for the defect. An interesting example of this kind has been reported by Jacobson, in which, the pulmonary artery being exceedingly narrowed, the bronchial arteries presented an extraordinary degree of development.

4. *Cirsoid dilatation.* This is a proper varicose condition of the arteries, and is identical in its general appearance with the same form of dilatation of the veins. Though long since noticed by Vidus Vidius, it has been but seldom alluded to by pathologists. Dupuytren applied to it the appellation of *arterial* varix, and Breschet, to whom we are indebted for the first satisfactory exposition of its characters, has called it cirsoid aneurism. It consists in a dilatation of one or more arteries, generally those of medium size, occupying a considerable portion of the length of the vessel, which is at the same time so much elongated, that it is folded and convoluted upon itself, precisely like a varicose vein. At the points of many of the principal flexures, the dilatation is often greater than in the intervals, and occasions rounded prominences of considerable size, which give the vessel an irregular knotted character. The coats of the vessels are generally attenuated and flaccid, and collapse when divided; but occasionally they are considerably thickened at some points, and are much harder and more rigid than natural. When superficial, these dilatations can be felt through the skin, presenting the character of uneven, convoluted, pulsating chords, and if the integuments are thin, the bright red colour of the arterial blood may be distinguished through the parts covering the dilated vessel. The varicose condition is indeed sometimes so great, as to form considerable pulsating tumours of variable extent along the course of the vessel, which may be partially emptied by compressing the artery above, so as to interrupt the passage of the blood.

According to Breschet, the arteries most liable to this variety of dilatation are the iliacs, carotids, brachial, femoral, tibial, occipital, auricular, radial, ulnar, the palmar and plantar arches, and the ophthalmic artery. He quotes from Vidus Vidius (*De curatione generative.* II. 510.) the case of a Florentine citizen, the arteries of whose head, from the vertex to the occiput, were so greatly dilated, that they resembled immense varices, and pulsated violently when touched. He has besides reported four cases, which he had himself observed, with delineations of the appearances presented by the parts. In all of them the vessels were preternaturally dilated, and exhibited the convoluted knotty arrangement of varicose veins. In the first, the dilatation affected the radial and ulnar arteries, and especially the vessels of the palm of the hand, which were rolled up into a convoluted mass, not unlike an aneurism by anastomosis. In the second, the tibial, peroneal, and tarsal arteries were involved, and the popliteal was affected with aneurism. In the third, the disease occupied nearly the whole of the ramifications of the temporal and occipital arteries; but the posterior tibial and peroneal were also affected. The whole arterial system, besides, seemed to be involved in this tendency, and the tunics of the vessels were so attenuated, that they collapsed like veins. In the fourth case, the affection was seated chiefly in the ramifications of the occipital artery, and gave rise to a morbid condition of all the adjacent portions of the head and neck. Besides these, a very interesting case has been reported by Jules Cloquet. The common, internal, and external iliacs, were of a remarkable size, and exhibited numerous tortuosities, which gave them much the appearance of the convolutions of the small intestines. The left iliac artery was much larger than the aorta, and the parietes of all of them were soft, flaccid, and collapsed, except in particular parts. They were besides unequally dilated at different points, and presented the irregular nodosities common to varicose veins. (*Surgical Pathology.* p. 113. Pl. III. fig. 1.)

5. *Aneurism by anastomosis.* (*Telangiecktasy.*) This form of dilatation is confined chiefly to the terminal ramifications of the arteries and the radicles of the veins, and the principal difference between it and the preceding variety consists in the fact, that the latter occupies branches of larger size. It sometimes gives rise to a reddish, or purplish pulsating tumour, composed of an intricate plexus of anastomosing vessels, but very often consists merely of an intense suffusion of the skin of the same colour, no tumour being perceptible. As this condition of the vessels will be particularly described in the article *Nævi materni*, we shall not notice its characters further in this place.

In nearly all cases in which the arteries

are dilated, they are found to have lost their elasticity, especially when the augmentation of the calibre of the vessel is considerable. In general, all the tunics can be distinctly recognized, but they are almost always altered in their texture. In some cases they are very much thickened —in others attenuated; and both these conditions may alternate with each other in the same vessel. In many instances, however, when the arteries are very much enlarged, the walls seem to be attenuated, and collapse when separated from their attachments with the surrounding parts, although they may be absolutely thicker than natural. This appearance is owing to the increased capacity of the vessel, which, when examined in relation to the thickness of its tunics, makes the latter seem thinner than they are in health. The coats of the vessel are besides often rendered preternaturally friable;—the lining membrane is often traversed by cracks or fissures, and atheromatous and calcareous deposits frequently take place, which so far enfeeble the tissues, that they may eventually give way, and lead to the transformation of a simple dilatation into aneurism or laceration of the vessel. Owing to the alterations of the lining membrane, and other arterial tunics, albuminous deposits and pseudo-membranes are occasionally formed upon the inner surface of the vessel, or loose fibrinous masses are developed by the coagulation of the blood, which impede the circulation through the part, and sometimes occasion complete obliteration.

The *causes* capable of giving rise to dilatation of the arteries are exceedingly variable, but may all be reduced to two heads, according as they impair the capability of the vessels to resist the distending influence of the blood, or augment the force with which that fluid is circulated. Amongst the first may be enumerated inflammation, both acute and chronic, and several of its consequences; violent stretching of the arteries; contusions; cartilaginous, osseous, and other transformations of their tunics; atheromatous deposits; softening; the changes produced in the texture of these vessels by gout, scrofula, syphilis, and various other diseases. Some have supposed that the fibrous coat of an artery is susceptible of experiencing a kind of paralysis, analogous to what takes place in muscular fibre, and that dilatation may arise from this cause. However this may be, there is abundant evidence to show, that when the powers of the system are greatly enfeebled, a laxity of the animal solids is generated, rendering them less capable than in health to resist those forces which are constantly acting on them. When any of these causes have predisposed the arteries to dilatation, that condition may be induced under the natural impulse of the circulation, independently of the co-operation of any other agency; but it will be doubly apt to occur, if, with a predisposition already formed, the force of the circulation should be preternaturally increased, either by the inordinate use of stimulating drinks or articles of diet, immoderate exercise, violent mental emotions, hypertrophy of the heart, or a mechanical obstruction to the free circulation of the blood through an artery. In this manner, dilatation of the arteries of many organs is induced by diseases involving their substance, and when the arterial ramifications of any of the tissues are predisposed to take on this condition, they seem to possess the faculty of inviting to the part such an increased flow of blood, as to occasion a preternatural distension of their tunics, precisely as the inordinate stimulation of an organ is capable of producing an inordinate congestion of its vessels. Dilatation of the arteries may likewise be produced by a long-continued general plethora, and its development takes place in some portions of these vessels much more readily than in others. Wherever they form considerable curves against which the column of blood must impinge,—as the arch of the aorta, &c.—at the angles formed by their divisions, when they are superficial and but slightly protected by surrounding structures, and when they are liable to be thrown out of the direction of a right line by the mobility of the adjacent parts, they are most prone to undergo this alteration of capacity. In many such situations, they are not only acted on by the force of lateral distension, but the column of blood being constantly driven with great force against their flexures and curves, and the projecting angles which correspond to the points of their bifurcation, it tends to occasion an elongation of the tube, which in proportion as it increases, necessarily gives to it a tortuous arrangement, such as is observed in the cirsoid dilatation described above.

The *symptoms* and *diagnosis* of dilatation of the arteries vary according to the vessels affected. When the disease occupies the aorta, it is often difficult to distinguish it from aneurism of that vessel, as it is often attended with the same embarrassment of the circulation, palpita-

tions of the heart, sense of suffocation, and difficulty of deglutition, from its encroachment upon the surrounding parts. There is also frequently a preternatural smallness of the pulse, and it is remarked by Hodgson, that the individual finds himself most comfortable on the left side, because in that position, the blood enters the orifice of the aorta with the greatest facility. When the dilated vessels are superficial, the disease can be generally distinguished by the feel, the artery being hard and tortuous like a varicose vein, but differing from it by its pulsation. Should several arterial ramifications be greatly dilated, they often present themselves in form of an irregular pulsating tumour, exhibiting a knotty convoluted appearance, and a deep red or purple suffusion. A dilated state of the vessels of the several organs occasions various disturbances of function, which, as they may be produced by other causes, cannot be relied on as indications of the existence of that condition. Thus, an affection of this kind implicating the arteries of the brain, may give rise to head-ache, vertigo, convulsions, or even apoplexy; and a similar state of the vessels of other organs, may occasion pain, and various diseased manifestations which it is needless to enumerate, since it is not possible to trace them to this cause during life.

It will not be necessary to say much of the *treatment* of this pathological state of the arteries. It is unfortunately seldom curable, and all that can be done is, to palliate the disturbance occasioned by it, and to obviate, as far as possible, its tendency to terminate in aneurism, or to destroy life either by giving rise to mortal congestions of important organs, or by rupture of some of the diseased vessels, which would often be productive of fatal hemorrhage. As a general rule, the same treatment will be indicated as for aneurism, and this will be more particularly the case when considerable dilatation affects the aorta, giving rise to serious disturbance of circulation and respiration. The diet of the patient should be regulated with care, and while it is sufficiently nutritious to obviate any considerable impairment of strength, all stimulating articles of both food and drink should be prohibited. Violent exercise, and all active emotions of the mind, should also be avoided. When the disease is troublesome, tranquillity is indispensably necessary, and it must be secured as well by an avoidance of all causes of irritation, as by a reduction of any preternatural excitement that may be at any time induced. Should congestions of the left side of the heart be developed by the obstacle to the passage of the blood through the aorta, they must be cautiously removed by small abstractions of blood, repeated from time to time as occasion may indicate. An over-distension of the vessels of the different organs must be treated in a similar manner. Mild saline aperients, cool refreshing drinks, digitalis, anodynes to allay preternatural nervous erethism, acetate of lead, prussic acid, &c., may all be employed with more or less prospect of advantage, under particular circumstances. Care must be taken, however, not to push the antiphlogistic remedies too far. It should be borne in mind that whatever tends to impair the powers of life, will enfeeble the tonicity of the vessels, and thereby rather increase than diminish the dilatation. The object of the remedies just enumerated is to overcome the tension of the vessels and to moderate the impulse of the heart, without enfeebling the energies of the system. It will indeed often be proper to sustain the latter in some cases, especially when it can be done without occasioning any acceleration of the action of the heart and arteries. With this view, and also with the object of increasing the cohesiveness of the tissues, various tonics and astringents have been recommended. The best will be the preparations of iron and zinc, sulphate of alumine, the vegetable bitters; and when the affected vessels are superficial, the application of slightly exciting and active astringent epithegms to the part; as lotions of alum, muriate of ammonia, acetate of lead, a strong decoction of galls or oak bark, and in some cases even ice or snow. Under the same circumstances, if the diseased vessels occupy the superficies of the head or one of the extremities, pressure, maintained by a roller bandage properly adjusted, will often prove serviceable, by furnishing an equable support to the dilated arteries, and preventing the increase of the disease. When the morbid condition of the vessels occasions a varicose or vascular tumour upon the head, it has been proposed to cut off the supply of blood by the application of a ligature to the common carotid artery, and if this should fail, owing to the free anastomosis, it has even been suggested to tie both carotids, leaving only the vertebrals to supply the brain and parts about the head. A similar operation has been successfully performed for aneurism by anastomosis, and it might possibly succeed in cases of extreme cirsoid

dilatation of the superficial arteries of the head and neck. The main artery might, on the same principles, be secured, when the disease affects the extremities, and proceeds so far as to render such a step necessary as a dernier resort. It must be very rare, however, that an operation can be admissible in any variety of the disease, and the practitioner will be compelled to content himself with palliating unpleasant symptoms, so far as he may be able, trusting the issue to time, and the powers of nature.

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§ 3. *Narrowing, obstruction, and obliteration of the arteries.* The arteries, under various circumstances, as well congenital as acquired, are liable to have their calibre narrowed, obstructed, or obliterated. This condition, so far as the aorta is concerned, has been already considered in the article in which we have treated of the pathology of that vessel. We there referred to all the cases of constriction and obliteration of the aorta which had been at that time published. But another instance, in which the abdominal portion of that vessel was obliterated, has been recently published by Louis, which we may refer to in this place. It occurred in an individual who died at La Pitié, of pulmonary disease. Notwithstanding the vessel was closed, the collateral vessels were not developed in a remarkable degree, nor was any defect of temperature observed in the lower limbs, although the femoral artery was also obliterated to a considerable extent. A very interesting case of narrowing of the abdominal aorta has been reported by Jules Cloquet. The subject of it was a rickety child, which laboured under deformity of the spine. The aorta followed exactly the curvatures of the vertebral column, and throughout its length, was bound down in such a manner, as to be doubled upon itself to the extent of two inches. The artery gradually diminished in size, towards the abdomen, to such an extent that the inferior portion of it was not more than a third of the diameter of the thoracic aorta. The inferior extremities were in a state of atrophy—probably in consequence of the obstruction to the course of the blood through the narrowed portion of the vessel. (*Surgical Pathology.* 125. Plate V. fig. 5.)

Narrowing of the calibre of an artery may be the result of a congenital defect of evolution: it may be produced by a simple constriction of the coats, more or less extensive, taking place at any period of life, without any alteration of texture; or it may arise from cartilaginous, steatomatous, calcareous, or other deposits in the tunics of the affected vessel. Several examples of each of these varieties of narrowing have been referred to in the article *Aorta;* and in some instances the pulmonary artery experiences the same modifications of capacity. Two cases of this kind are described by Hellioston. In one of them, the size of the vessel was so much reduced as scarcely to admit the little finger, and in the other, it was not larger than the brachial artery. (Bérard. *Dict. de Méd.* IV. 116.) A case was also observed by Jacobson, in which the individual was affected with cyanosis. The pulmonary artery was not more than one-fourth the size of the aorta, but the bronchial arteries were very much enlarged. (Meckel's *Archives für Physiologie.* II. 134. Berlin, 1816.) Another example of the same disease has been described by Knox, in which the pulmonary artery was reduced to the size of a small goose quill. (*Edinb. Med. and Surg. Journal.* XI. 57.) Various other arteries of the body are frequently found affected with more or less narrowing or constriction. Sometimes, indeed, the capacity of nearly the whole arterial system is found diminished. This is particularly observed in individuals affected with general atrophy, phthisis pulmonalis, and several other affections in which the quantity of blood is greatly diminished. The atrophy of an organ is likewise attended with a diminution of the capacity of its vessels, and when it is extreme, the greater part of them are sometimes entirely obliterated. Instances in which the arteries are preternaturally small in relation to the heart, are not unusual, many such having been described by Morgagni and others. But

when the liability of the latter organ to become enlarged is considered, the impropriety of regarding all such cases as examples of narrowing or constriction of the vessels will be apparent.

Obstruction and obliteration of the arteries, like constriction, may be either congenital or acquired. It may take place without any important alteration of the texture of the vessel, or at least without any transformation or degeneration of its tunics;—by the development of coagulated or fibrinous concretions, or albuminous deposits within its calibre;—steatomatous, cartilaginous, or earthy formations encroaching upon, or filling up the tube, or by the spontaneous cure of old aneurisms.

The best examples of the first are furnished by the obliteration of the ductus arteriosus, and the umbilical arteries of the fœtus, which takes place as a natural result after birth. The obliteration of an artery which follows the application of a ligature, or the long-continued influence of pressure, seems also to partake somewhat of this character; and in describing the pathology of the aorta, we referred to examples of constriction and obliteration of that vessel, which were of the same nature. In some instances the obliteration is of very limited extent, and presents the appearance of a thread or ligature, drawn tightly round the vessel. Sometimes it extends along the artery in a longitudinal direction to a considerable extent, and converts it into a solid impervious chord. When the constriction does not entirely close the artery, there is often more or less dilatation of the vessel above the narrowed point, and in some cases also below. This form of constriction and obliteration, when it is congenital, is doubtless owing to an arrest of development taking place in the part, and is analogous to the examples of atresia which are sometimes observed in other hollow organs. But when it occurs at a later period of life, it may be produced either by inflammation and a deposit of coagulable lymph, or by a species of organic contraction of the coats of the vessel, which is more active at the affected point than in any other situation. This condition has been compared to the spasm which affects the hollow organs possessed of muscular fibres; but the parallel is not just, because it is the character of muscular spasms to relax, when the exciting cause ceases to operate.

By far the most frequent cause of obstruction and obliteration of arteries is, the formation of fibrinous concretions within their calibre, and the deposit of an albuminous or organizable fluid, which possesses the faculty of establishing adhesions between the corresponding surfaces of the lining membrane. There are various causes which are capable of giving rise to the formation of these concretions. They are developed when a ligature is applied to an artery, or when the course of the blood through it is interrupted for some time by pressure, or in any other manner. They also occur, sometimes, when a partial laceration or violent contusion has been inflicted, and always, if we may confide in the results of experiments made on living animals, when an incised wound implicates three-fourths or two-thirds of the circumference. (Bérard.) In some cases, even slight wounds of the smaller arteries are sufficient to produce the effect; but in such instances, it seems to be accomplished by the direct intervention of the inflammation excited by the injury. The agency of arteritis in the development of fibrinous plugs or concretions in the vessels, has already been mentioned in a preceding section, and it is unquestionably the most frequent cause of the species of obstruction and obliteration now under review. The tendency of inflammation of arteries of moderate size to give rise to coagulation of the blood within them, is a fact now so well established, that it cannot admit of a doubt. But the manner in which it produces this effect is not easy to decide. One of the effects of inflammation on the arterial tunics is, to produce a tumid, spongy, and rough disposition of the lining membrane, and a deposit of albuminous matter, which forms a pulpy or flocculent pseudo-membranous concretion upon its inner surface. These conditions will naturally tend to exercise a mechanical influence upon the stream of blood, and it is highly probable, that by interrupting or retarding its transmission through the vessel, they may conduce to the coagulation of that fluid, and the development of the fibrinous plugs under consideration. But in addition to this agency, it may admit of a question, whether an inflamed artery is not capable of exercising some vital influence directly upon the blood itself, disposing it to coagulate, independently of any mechanical impediment to its free transmission through the vessel. This opinion has been adopted by Cruveilhier, Bérard, and several other respectable pathologists, and there are various circumstances which render it highly plausible.

Amongst these, we may mention the very early period at which these plugs are formed after the inflammation has set in, their frequent coexistence with that condition in arteries which are inflamed to a considerable extent, and when no adequate changes have taken place in the lining membrane to produce the coagulation and consequent obstruction by a mechanical influence, and the intimate relationship which exists between these concretions and gangrene, in which traces of arteritis can be almost always recognized, except when the mortification results from some cause purely mechanical in its operation. We have already adverted to the close connexion between arteritis and this latter condition, and have remarked, that in all cases of spontaneous gangrene, the arteries are plugged up with fibrinous masses, which are accurately moulded to their inner surface, and very frequently occupy their calibre even for a considerable distance above the limit of the mortification —always almost as high as the origin of the nearest collateral vessel above that point. These plugs may be drawn out in form of round, elongated masses, having the exact impress of the cavity of the artery. They are generally soft and of a fragile consistence; but it will sometimes be found, if the vessel be cautiously laid open, that they adhere slightly at some points to the lining membrane, by means of a viscid albuminous material, which is poured out by the inflamed tissue. Sometimes, indeed, distinct pseudo-membranous deposits are formed, provided sufficient time has elapsed, and the internal surface of the artery is found red, spongy, villous, and exhibiting all the characters of acute inflammation. Should all the principal arteries of a limb be obstructed in this manner to a considerable extent, so as to cut off the necessary supply of blood, gangrene will speedily supervene; but when the obstacle is of limited extent, and the collateral vessels remain pervious, the limb does not mortify, but plastic lymph is poured out in considerable quantity between the inner surface of the artery and the coagulum; the latter is gradually absorbed while the former becomes concrete and organized; and the final result is the total obliteration of the vessel, and its conversion into a small compact chord, of a cellulo-fibrous consistence.

In reference to the connexion between the formation of these fibrinous obstructions in the arteries, and the development of gangrene, it may be proper to remark, that some pathologists consider the coagulation of the blood as a consequence merely of the previous death of the parts, and their inability to circulate the blood through themselves. In whatever manner this doctrine be construed, it is liable to many objections. If the coagulation of the blood, and the formation of these fibrinous plugs, were consequences of gangrene, they should not be formed above the limit of the dead parts—at least they should not extend higher than the origin of the nearest collateral vessels. Yet they are not unfrequently observed reaching far above that point, and in cases of gangrene of the leg, have been met with plugging up the main artery of the limb, as high as Poupart's ligament, or even farther. Besides, the obstructed artery in such cases, above the seat of the gangrene, presents the ordinary indications of inflammation. If, as represented by Alibert, the coagulation of the blood were owing to a previous diseased condition of that fluid, and the arteritis a consequence of the formation of the fibrinous concretions, there is no reason, as Bérard has very properly remarked, why it should become consolidated in one set of vessels in preference to another; nor does it accord with sound philosophy to attribute spontaneous gangrene to this cause, when the whole category of the phenomena which attend the form of it now in question, indicates arteritis as the first link in the chain of causation—the coagulation of the blood, and the obstruction of the vessels, as the second, and the death of the parts as the necessary consequence of their supply of blood being cut off. These principles were strikingly exemplified in a case of spontaneous gangrene which we had an opportunity of witnessing a few months ago. The individual was a lady aged forty-five or fifty. She was first attacked with excruciating pain of the foot, without either redness, tumefaction, or elevation of temperature. The parts soon became cold and œdematous, and finally gangrene made its appearance in the great toe, and gradually extended up the leg, to the vicinity of the knee,—the violent pain continuing all the time without any abatement. The pulsation of the popliteal artery was completely annihilated, and that of the femoral was exceedingly obscure, as high even as the vicinity of Poupart's ligament. The limb was amputated through the thigh, and on examining the arteries, they were all found occupied by fibrinous plugs, their coats very much thickened, and otherwise diseased. The thickening existed also in the popliteal

and femoral arteries, to such a degree as to diminish their calibre. Here then we have the development of arteritis attended with acute pain. The vessels soon became obliterated by the coagulation of the blood within them and its conversion into fibrinous plugs. To this succeeded coldness, extinction of pulsation, and œdema, which, it will be remembered, are characters of arteritis attended with obstruction; and as a final result, gangrene was developed. A few years ago, we witnessed almost precisely the same result in an aged female, except that the œdema extended as high as POUPART's ligament, and the closure of the arteries reached above that point. These facts strongly corroborate the inference that arteritis is not only a frequent cause of obliteration of the arteries, but that it tends indirectly to the development of spontaneous gangrene. It must not be inferred, however, that it is always the cause of this disease; since, as we have previously remarked, it may be induced by various other conditions.

Inflammation affecting the larger arteries, does not so readily give rise to obliteration, but often occasions considerable obstruction to the passage of the blood through those vessels. In such cases, either albuminous pseudo-membranes form upon the inner surface of the artery, or fibrinous concretions are developed in the same situation, which adhere to the lining membrane for some distance, and when they attain a considerable degree of thickness, encroach so much upon the lumen of the vessel as to leave a very narrow passage for the transmission of the blood. These changes are frequently developed in some cases of dilatation of the arteries, and they may likewise take place when no previous augmentation of diameter has occurred.

Another frequent cause of obstruction and obliteration of the arteries is, the development of the various alterations of their tunics, which have been described in a preceding section, as consequences of chronic inflammation. The formation of cracks and fissures in the lining membrane, ulceration and erosion of that tissue, the development of calcareous and steatomatous or atheromatous masses, and various other morbid conditions of the arterial tunics, all have a tendency to impede the even current of the circulating blood, and a portion of that fluid being entangled by their inequalities, masses of coaguli are formed, which by continued accretion, finally attain so large a size, as to obstruct, or completely close the calibre of the vessel. It is not unusual for such obstructions to take place in old persons, in consequence of extreme ossification of the arteries. Several of the cases of obstruction and obliteration of the aorta referred to under that head, were owing to this cause; and its tendency to produce gangrene, when the arteries of the extremities are affected, was long since noticed by COWPER. (*Phil. Transactions.* 1703.) We have witnessed as many as three cases of spontaneous gangrene of the foot, which were owing to ossification and obliteration of the anterior tibial artery, and the connexion between these two conditions has been so repeatedly noticed by modern pathologists, that there is at present no question of the dependence of many cases of spontaneous gangrene upon this cause. A case, however, is reported by WILLIS (*Cerebri Anat.* Cap. lxx.), in which the right carotid, and the corresponding vertebral artery, were ossified and obliterated, yet the individual experienced no inconvenience. In the body of a person who died of senile gangrene, CRUVEILHIER found the orifice of the right carotid obstructed by a grayish-coloured tumour of a fibrinous consistence, and the left internal carotid ossified at its origin, and entirely obliterated as far as where it enters the petrous portion of the temporal bone. (*Essai sur l'Anat. Path.* II. 58.) The same author also mentions another case, in which the left primitive carotid was plugged by a red fibrinous concretion, half an inch in length, which was intimately united to the inner surface of the vessel, and the origin of the external carotid reduced almost to a capillary tube by a yellowish-coloured substance, covered by several laminæ of a fibro-cartilaginous texture. The external carotid, with its branches, was diminished very much in size. We have already referred to a case observed by STENZEL, in which the aorta was obstructed by two large steatomatous tumours; and in addition to other examples of obstruction and obliteration enumerated in the article appropriated to the pathology of that vessel, the following may be cited: DE HAEN found nearly the whole arterial system containing fibrinous concretions. (*Rat. Med.* II. Pars vi. Cap. 4.) In a case observed by PETIT, the carotid artery was obliterated and converted into a ligamentous chord. (*Mém. de l'Acad. des Sc.* 1765.) Other examples of obstruction and obliteration of this vessel have been reported by HALLER (*Opera Minora.* III. 303.), DARRACH (*Philada.*

Journ. XIII. 1826.), and of the branches of the internal carotid, by Hodgson. (*Op. Cit.* p. 32.) Bérard also states, that in an individual affected with gangrene of one hemisphere of the brain, he found the corresponding arteries obliterated by fibrinous concretions. (*Dict. de Méd.* IV. 119.) Jadelot has described a case, in which both carotids were obliterated by ossification. (Naumann. *Klinik.* II. 620.) In the case observed by Darrach, just referred to, the innominata, and the adjacent portion of the right subclavian, were also obliterated; and Pelletan has described an instance, in which the subclavian and axillary arteries were fonnd in the same condition. (*Clinique Chirurgicale.* I. 77.) Examples of obliteration of the brachial artery have been described by Hodgson (*Op. Cit.*), Ribes (*Bulletin de la Faculté.* 1817.), Rostan (*Journ. de Méd.* I. 81. 1818.), and Pelletan (*Op. Cit.* I. 68.). The external iliac was found obliterated in a case of gangrene, by Bryant. (*Edinb. Med. and Surg. Journal.* XIX. 45.) Ribes observed the same condition in the popliteal artery (*Op. Cit.*), Hodgson in the femoral (*Op. Cit.* p. 22.; and obliteration of the tibial arteries has been so frequently met with, in cases of gangrene of the foot and leg, that it is not necessary to specify particular instances. When glandular organs become greatly atrophied, it is not unusual to find the principal part of their vessels either impervious, or so remarkably small, that they are incapable of conveying much blood. This is often observed in the liver, kidneys, &c., and it constantly takes place in the thymus gland some time after birth. The same change sometimes occurs in the arteries of glands affected with certain morbid developments. Not long since, we assisted our friend and colleague, Professor N. R. Smith, in the removal of a very large tumour of the thyroid gland, and notwithstanding the extensive dissections which were necessary, he was scarcely obliged to tie any other artery than the superior thyroid of the right side —all the rest being either obliterated, or so small as not to require a ligature.

The manner in which aneurism is sometimes cured spontaneously, by the obliteration of the sac and the adjacent portion of the vessel, has been described in the article which treats of that disease. Another cause of obstruction of arteries has been mentioned by Turner, which in its nature presents many points of analogy with aneurism. It consists in the laceration of the lining membrane of the vessel, and its detachment to such an extent, that by projecting into the cavity, it forms an obstacle against the free passage of the blood, which consequently becomes coagulated, and finally occasions complete obliteration, attended with coldness of the limb, want of sensibility, œdema, gangrene, and the ordinary phenomena attendant on obstruction from other causes. This condition is analogous to the dissecting aneurisms described by Laennec, Guthrie, and others, and is most apt to occur in the vicinity of the movable articulations. It cannot take place, unless the coats of the vessel be previously diseased; because under other circumstances, their elasticity and powers of resistance will be adequate to protect them against injury. Several cases of this form of obstruction have been reported by Turner (*Transactions of the Medico-Chirurgical Society of Edinburgh.* I. 105 and 308.); and the same condition of the arteries has been described by Laennec, Hodgson, Guthrie, Lobstein, and others.

The consequences of obstruction and obliteration of the arteries are exceedingly variable, according to the extent of the closure, and the freedom of the collateral anastomoses. They have been so far pointed out in the course of the preceding remarks, that they need not be detailed in the present place. It will be sufficient to remark, that when the obstruction occupies a great extent of a principal artery, gangrene will very generally ensue. This does not often happen when the closure is of limited extent; because under such circumstances, the anastomosing vessels become sufficiently enlarged to compensate for the suspension of the circulation through the main trunk. This takes place as well when a ligature is applied to an artery, as when it is obliterated spontaneously. Whether it is accomplished entirely by the simple enlargement of the anastomosing arteries already existing, or partly by the development of new vessels, is a question not yet satisfactorily decided. We shall not, however, discuss the subject in this place, but refer for further information, to the articles *Aneurism*, *Ligature*, and *Capillaries*.

Obstruction of the arteries may also produce paralysis of the affected limb (Rostan, Bogros, Bérard, *Op. Cit.* p. 120.), atrophy of the parts to which it is distributed, and preternatural dilatation of other portions of the arterial system with all its consequences.

§ 4. *Perforation and rupture of the arteries.* The coats of the arteries may be per-

forated or ruptured, either in consequence of changes commencing primarily in themselves, or by the influence of causes operating on them from without, or extending to them from the adjacent structures. To the first class of causes we may refer the various alterations of texture described under the head of inflammation; as softening, attenuation, ulceration; atheromatous, steatomatous, calcareous, and other deposits;—also aneurism:—to the second, ulceration, mortification, cancerous degeneration, and other analogous morbid conditions originating in the structures adjacent to the vessel;—wounds and contusions; spiculæ of bone; violence inflicted in dislocations or in attempts to reduce them after they have existed long enough to allow the vessel to contract preternatural adhesions,—and the contusion and laceration inflicted upon the neighbouring parts by the passage of a ball, or other injuries of a similar nature. Most of these causes, it will be observed, operate either by occasioning a direct solution of continuity, or by so far enfeebling the texture of the walls of the vessel, that they become incapable of sustaining the distension or impulse occasioned by the circulation of the blood. Under the latter circumstance, the mischief proceeds gradually: by disease, the thickness or the cohesive power of the vessel becomes so far diminished, that under the influence of some bodily exertion, the weakened point gives way, and the blood is either extravasated in the surrounding tissues, thrown into one of the natural cavities or hollow organs, or discharged externally. In the first case, the rupture or perforation gives rise to a diffused aneurism: under either of the other circumstances, the individual is destroyed by hemorrhage, unless the artery should be small, or so situated as to admit of surgical relief. It rarely happens that an artery is ruptured without any previous disease of its tunics. Yet such an accident sometimes takes place from great violence, or a sudden commotion,—as in falling from a height,—by the body being crushed between two solid points of resistance, or by a heavy weight passing over it, and when an artery is forcibly elongated or twisted.

Rupture of the aorta has been considered in a previous article, and numerous examples were referred to. We might cite a great number of cases of the same accident happening in other vessels, were it not that they are too numerous to be noticed individually. Those who may desire to refer to such cases, will find a copious list of citations in Ploucquet (*Bibliotheca Med. Practicæ.* I. 423.), and Otto (*Lehrbuch der Pathologisch. Anatomie.* I. 333 and 338.

§. 5. *Wounds and injuries of arteries.* Few subjects pertaining to surgical pathology are more important than wounds and other injuries of the arteries. The alarming and often fatal hemorrhage with which they are attended, independently of their liability to occasion gangrene of the parts receiving their blood through the injured vessel, renders them an object deserving the closest attention, since it is only by a proper understanding of the important steps adopted by nature to obviate or overcome their formidable consequences, that the surgeon can be qualified to institute a rational and successful method of treatment. Under the head of injuries of the arteries, may be included, 1. punctured, 2. incised, and 3. lacerated wounds, implicating either one or more of their tunics; contusions resulting from external violence, and the preternatural stretching of their tissues which takes place from violence operating upon parts through which they pass. The changes produced in them by the application of ligatures for the suppression of hemorrhage, fall properly under the same head; but as they will be considered in an article appropriated specially to that subject, they will only be noticed incidentally in the present article.

1. *Punctured wounds of the arteries.* Experiments on animals have shown, that when an artery is punctured by a fine sharp-pointed round instrument, as, for example, a needle, the blood which issues from the orifice is extravasated beneath the adjacent portion of the sheath, and in the meshes of the cellular tissue surrounding the wounded portion of the vessel. This coagulates and forms a small projection, or thrombus, which effectually closes up the puncture. After the expiration of a few hours, coagulable lymph is effused by the irritated vasa vasorum, which agglutinates the meshes of the tissue; and in the course of a few days the coagulated blood is absorbed, and the plastic lymph effused in the vicinity of the injury becomes consolidated and forms a small cicatrix, which effectually restores the breach made in the arterial tunics, and leaves them in possession of as much strength as they had before the infliction of the wound. The course of the blood through the artery is not in the slightest degree interrupted, and if the vessel be

laid open after the cure is effected, it will often be impossible to discover upon its inner surface the exact seat of the puncture. In some instances, however, a small point, of variable extent, differing from the adjacent portion of the lining membrane in colour, will indicate the site of the cicatrix, and if considerable inflammation has existed, this will be the more conspicuous. It may happen, indeed, when the wounded artery is not very large, and violent inflammation ensues, that a considerable effusion of coagulated lymph takes place within the vessel, attended with the formation of a fibrinous concretion, and a complete obliteration of its calibre, as sometimes occurs from arteritis induced by other causes. The salutary efforts of nature may, besides, be thwarted by the development of ulceration. GUTHRIE states that in two instances in which he saw the femoral artery wounded by the tenaculum, ulceration followed by hemorrhage took place, requiring the application of a ligature. (*Diseases and injuries of the arteries.* p. 212.)

2. *Incised wounds of arteries* may be divided according to their depth, into those which merely sever the external tunics, and such as penetrate the cavity of the vessel.

a. *Superficial, or non-penetrating wounds.* The simple division of the sheath of an artery does not usually occasion any serious consequences. A slight oozing of blood takes place for a short time, but coagulable lymph is soon poured out, and the injury is repaired in the same manner as in simple wounds of other parts; or if the external opening of the integuments be not closed, suppuration may ensue, and the part will be healed by granulation. Should the cellular coat of the vessel be divided simultaneously with the sheath, the fibrous and internal coats will usually possess sufficient strength to prevent the development of any dilatation at the seat of injury, and the solution of continuity will be repaired in the same manner as in wounds confined to the sheath. Such an injury will seldom give rise to aneurism —probably never, unless considerable inflammation should take place, occasioning softening of the fibrous coat; in which case it is possible that it might yield to the distending influence of the blood, and form an aneurismal tumour, as represented by CALLISEN. This accident will be still more apt to occur if the wound should suppurate; and under such circumstances, perforation may finally take place, without any previous dilatation of the vessel at the seat of injury, giving rise to fatal hemorrhage. A wound penetrating still deeper, so as to divide the fibrous coat partially or completely, constitutes a much more serious injury. In such cases, the walls of the vessel are rendered too feeble to sustain the impetus of the column of blood, and the thin lining membrane will either become dilated at the seat of the wound, so as to protrude through the opening of the other tunics in form of a small thin aneurismal sac, or it will give way and occasion profuse hemorrhage. In speaking of mixed aneurism of the aorta, it was remarked that HALLER had long ago proved by experiments made on the mesenteric arteries of frogs, that aneurismal dilatation of the lining membrane took place when the cellular and fibrous coats of the vessel were destroyed; and notwithstanding the assertion of JOHN HUNTER, that the deposit of coagulable lymph at the seat of such injuries renders the coats of the vessels thicker and stronger than at other points, subsequent observations of DUBOIS, DUPUYTREN, TROUSSEAU and LEBLANC, and LAUTH, prove clearly that such aneurisms may form from the destruction of the outer tunics of an artery. In some cases, however, no dilatation takes place, but the internal tunic resists the distending influence of the blood, until it becomes weakened by disease, when it ruptures and a copious hemorrhage results. A case is mentioned by GUTHRIE, in which a penetrating wound of the neck partly severed the internal jugular vein, and at the same time divided the cellular and fibrous coats of the carotid artery. The lips of the wounded vein were pinched up and surrounded by a ligature, leaving the calibre of that vessel pervious. The artery was not tied, and on the eighth day, the internal coat gave way, and hemorrhage took place. A ligature was then applied to both the lower and upper ends of the artery, there being profuse reflux bleeding; but the individual died the next day. (*Op. Cit.* p. 328.)

b. *Penetrating wounds.* When an artery has been wounded, the consequences will be different according to the size of the vessel injured. The extent and direction of the wound will also exercise more or less influence upon the phenomena developed,—the changes induced by a partial division of the vessel in either a longitudinal, transverse, or oblique direction, being somewhat different from those which follow when it is cut entirely across. If the injury be confined to the small arterial ramifications, there is merely a

trickling of blood from the wound, which gradually diminishes in quantity, and finally disappears. The space between the lips of the severed tissues will be found, when the bleeding has ceased, filled by a mass of coagulated blood, and after a short time coagulable lymph will be poured out, the coagulum will be gradually absorbed, and the solution of continuity will be restored by adhesive inflammation. But when an artery of considerable size is wounded, either by a puncture with a sharp instrument, or by a clean incision, the bright vermilion arterial blood is thrown out in jets, corresponding to the systole of the heart, and describing unequal parabolas. The stream will cease when the artery is compressed between the wound and the heart, but will be generally increased when the pressure is applied to the vessel beyond the seat of the injury. The manner in which the blood escapes may, however, be considerably modified by contingent circumstances. It may happen, from the great depth of the vessel, the character and extent of the injury, and the relations of the external parts with the opening in the vessel, that the jet of blood will be broken, so as not to issue *per saltem*, but flow from the wound in a uniform stream. This will be more apt to occur when the external wound is narrow, and especially when, from the mobility of the parts, or the retraction of the artery, the relations of the wound of the vessel with that of the sheath become changed. A careless examination under such circumstances might lead to the inference that no artery has been wounded, because the blood is not thrown out in jets; but if in addition to the vermilion hue of the blood, it is remarked that it is discharged *in waves*, which are synchronous with the systole of the heart, such a mistake can be readily avoided.

Should the external opening be too narrow to allow the blood to escape freely, or the relation between the opening of the artery and its sheath, or the surrounding structures, become altered, that fluid will be driven extensively into the cellular tissue, where it will form a diffused mass of coagula beneath the fascia, to which a general thrill will be communicated by the projection of the fluid blood into it through the orifice of the vessel, at each contraction of the ventricle. The part thus affected, generally presents, when the extravasation is considerable, a dark or blood-shot appearance, and often has one point softer than the rest, in which the blood preserves its fluid character, and the pulsation communicated to it by the wounded vessel can be distinctly felt. This constitutes the condition denominated primitive diffused aneurism, which has been described in a previous article. (See *Aneurism.*)

When the wound is first inflicted, the blood issues from the vessel with great impetuosity; but after it has flowed for a few seconds, the action of the heart becomes so feeble, that the stream is projected with less force, the blood is infiltrated in the meshes of the adjacent tissues, and beneath the sheath of the vessel, where it coagulates and forms an obstacle to the continuance of the hemorrhage, and if artificial means be not resorted to for the purpose of arresting it, syncope finally takes place from the excessive loss of the vital fluid. In this condition all bleeding ceases, and during the quiescent state of the heart and arteries, still more extensive coagula form around the vessel at the seat of injury and in its orifice, so that in many cases, after the individual revives, the circulation being languid, the barrier thus formed prevents the recurrence of hemorrhage, and a cure may be effected by the spontaneous efforts of nature. Very often, however, these salutary provisions only afford a temporary respite; for so soon as animation is restored, and the circulation regains some power, the coagula plugging up the orifice of the wound give way, thus giving rise to a renewal of the bleeding, which may be again suspended by the same causes, or it may continue until life is destroyed by the loss of blood. This is what takes place when the case is left to the unassisted powers of nature, and in many instances, the alternate suspension and renewal of the hemorrhage occur several times before it is finally arrested, or death ensues. The facility with which the flow of blood is stopped by the concurrence of the circumstances just adverted to, will be so much influenced by the character and extent of the wound, that it will be necessary, in order to comprehend the manner in which it is accomplished, to consider the changes which ensue when the artery is completely divided, and to compare them with those which are developed when it is only severed partially, by either a longitudinal, transverse, or oblique wound.

a. Spontaneous cessation of hemorrhage when an artery is entirely divided. If an artery of large size be entirely cut across, the blood will be projected from the wound with considerable force, and

will generally continue to flow until death takes place, unless some artificial means be resorted to for the purpose of arresting it. Sometimes, nevertheless, if the external opening be very contracted, and especially if the lips of the wound be narrow, the enfeebled action of the heart and arteries induced by the loss of blood, the total suspension of the circulation by syncope, together with the retraction of the divided artery within its sheath, may allow the orifice of the bleeding vessel and the adjacent parts to become so plugged up with coagula, as to prevent a recurrence of the hemorrhage when the patient revives, and thus secure a favourable termination. This fortunate issue will be still more likely to be realized, when the wounded artery is small or of medium size; for under such circumstances, the conservative powers of nature will often be found sufficient to prevent the hemorrhage from continuing sufficiently long to destroy life. This being the case, it becomes essential that the surgeon should be acquainted with the steps by which so important an object is consummated as the spontaneous cessation of hemorrhage, since upon this knowledge should be predicated the artificial means he adopts to secure the same end.

The ancients, though acquainted with most of the means at present employed to stop the flow of blood from wounded arteries, did not understand the manner in which they accomplish that end. To PETIT we are indebted for the first rational explanation of the process by which hemorrhage is arrested spontaneously. From numerous observations, he arrived at the conclusion, that the bleeding from a divided artery is arrested by the formation of a clot, partly within the vessel, and in part exterior to its cavity. The external coagulum he supposed is formed by the last drops of blood as they are issuing from the wound; the internal, which he says is small, is formed by the portion of the blood still contained within the end of the artery. The outer coagulum, which surrounds the end of the wounded vessel, he denominated *couvercle*, or cover, while to the inner one he applied the appellation of *bouchon*, or cork. Having explained the manner in which the wound is closed by these two coagula, he subjoins, that a whitish substance is mixed with the rest of the mass, which unites the clot to the surface of the vessel. (*Mémoires de l'Acad. des Sc.* 1731.)

This explanation, as far as it goes, is highly satisfactory; but as it does not include the changes which take place in the end of the vessel itself, the infiltration of the blood into the surrounding cellular tissue, and some other collateral circumstances, it is defective. MORAND, perceiving these objections, made an important addition to the doctrine of his predecessor, by explaining the manner in which the vessel itself, as well as the blood, performs an important part in suppressing hemorrhage. Admitting the agency of the coagula as it had been explained by PETIT, he attributed still more importance to a kind of corrugation of the coats of the artery, resulting from the contraction of its circular fibres, and a shortening of the vessel, produced, as he supposed, by the contraction of longitudinal fibres. The longitudinal fibres, it is now well known, do not exist in the arteries; yet the contraction of the end of the wounded vessel, and its retraction within its sheath, cannot be denied, and MORAND only erred in his manner of explaining one of these changes. They both constitute very efficient steps in the process by which hemorrhage is suppressed, and form an important addition to the explanation previously offered by PETIT.

The doctrine of the spontaneous cessation of bleeding from wounded arteries, thus improved, was adopted by SHARP, who, in making the assertion, that the blood-vessels, immediately upon their division, bleed freely, and continue bleeding till they are either stopped by art, or at length contracting and withdrawing themselves into the wound, their extremities are shut up by the coagulated blood, very properly blends the explanations of both PETIT and MORAND.

POUTEAU strongly contested the accuracy of these opinions. He affirmed that in many cases no coagulum is formed within the vessel, as represented by PETIT, and that in several amputated stumps which he examined several days after the operation, when the hemorrhage had been commanded by ligature, compression, or caustic, he seldom found any traces of coagulum. Even when it does occur, he denies that it performs any efficient part in stopping the blood, since it is too small to close the vessel, which is, notwithstanding, obliterated. He also denied that the vessel retracts, and in corroboration of this assertion, stated that he had seen arteries hanging out from the stump after amputation of the penis, and the fore-arm. Instead, therefore, of adopting the doctrine of PETIT and MORAND, he attributed

the cessation of hemorrhage to the tumefaction of the parts surrounding the artery, and the consequent pressure upon the vessel. Hence, with the view of promoting the swelling and induration of the surrounding structures, he proposed, in applying the ligature, to include them in the knot. It should be remarked, however, that in arriving at these conclusions, POUTEAU was influenced by the condition presented by the wounded arteries some time after the bleeding had been arrested by artificial means, and that he rejected an experiment made on a horse, in which the artery was found in the condition represented by PETIT, as not applicable to the point.

According to GOOCH, hemorrhage from divided arteries is arrested by the retraction of the vessel, which collapses and coalesces as far as its first ramifications, and has its mouth soon sealed up with flesh, growing from the nutritious vessels; and a similar opinion is adopted by KIRKLAND, WHITE, and AIKEN. The first of these gentlemen adduces some experiments to prove, that the spontaneous cessation of hemorrhage is owing to the contraction of the end of the artery; but it has been very properly remarked by JONES, that his inferences are invalidated, because, instead of leaving the wound to the operations of nature, he employed pressure, and even resorted to the application of the ligature and other means, which would of course materially modify the changes supervening after the infliction of the wound. The results of his investigations led him to the conclusion, that the bleeding is not suppressed by a coagulum, but by the close contraction of the vessel to the extent of an inch or more from its extremity. He nevertheless admits, that if the hemorrhage be suppressed by placing a piece of agaric near the orifice of the vessel, instead of placing it over it, a coagulum may form in the orifice; yet both himself and WHITE, who adopted all his views, affirm that this is more prejudicial than otherwise, and the latter represents, that except when it is so situated as to be excluded from the air, it ought to be removed.

JOHN BELL adopted a still more limited view of the subject, and after reviewing the doctrines of his predecessors, he expresses his own opinion to the effect, that when hemorrhage stops of its own accord, it is neither from the retraction of the artery, nor the constriction of its fibres, nor the formation of clots, but by the cellular tissue which surrounds the artery being injected with blood. This blood coagulates and forms a sufficient barrier to restrain the bleeding of a small artery, till the parts inflame, and the artery is entirely stopped.

The doctrines relating to the spontaneous cessation of hemorrhage remained in this state of contradiction and uncertainty, until JONES, actuated by a desire of arriving at the truth, instituted a laborious series of experiments, which resulted in a complete confirmation of some of the views of PETIT, with the establishment of some new principles besides, which perform an important part in the process. Similar experiments were subsequently performed by BECLARD, and since his time they have been repeated by several individuals, with a general confirmation of the views adopted by both JONES and himself. These experiments prove "that the blood, the action and even the structure of the arteries, their sheath, and the cellular substance connecting them with it,—in short, that all the parts concerned in or affected by hemorrhage, contribute to arrest its fatal progress, by operating, in the case of a divided artery of moderate size, in the following manner:

"An impetuous flow of blood, a sudden and forcible retraction of the artery within its sheath, and a slight contraction of its extremity, are the immediate and almost simultaneous effects of its division. The natural impulse, however, with which the blood is driven on, in some measure counteracts the retraction, and resists the contraction of the artery. The blood is effused into the cellular substance between the artery and its sheath, and passing through the canal of the sheath which had been formed by the retraction of the artery, flows freely externally, or is extravasated into the surrounding cellular membrane, in proportion to the open or confined state of the external wound. The retracting artery leaves the internal surface of the sheath uneven, by lacerating or stretching the cellular fibres that connected them. These fibres entangle the blood as it flows, and thus the foundation is laid for the formation of a coagulum at the mouth of the vessel, and which appears to be completed by the blood, as it passes through this canal of the sheath, gradually adhering and coagulating around its internal surface, till it completely fills it up from the circumference to the centre. A certain degree of obstruction to the hemorrhage, which results from the effusion of blood into the surrounding cellular membrane, and between the artery

and its sheath, but particularly the diminished force and velocity of the circulation, occasioned by the hemorrhage, and the speedy coagulation of the blood, which is a well-known consequence of such diminished action of the vascular system, most essentially contribute to the accomplishment of this important and desirable effect." (JONES. *On the process employed by nature in suppressing hemorrhage.* p. 53.)

It will thus be seen, that one of the first steps, after the retraction and contraction of the artery, is the formation of a coagulum within its sheath, and in the surrounding cellular tissue. This is the *couvercle* of PETIT, and the external coagulum of JONES. It appears on first examination, like a continuation of the artery; but on cutting open the latter, its mouth is found completely closed by the coagulum, which is also inclosed in the sheath. The blood being thus prevented from escaping, that portion of it which remains within the divided end of the artery, coagulates and forms a long slender conical clot, the point of which looks towards the heart. This generally extends as high as the origin of the nearest collateral branch, but neither fills the vessel, nor adheres to its tunics, except at its base, where it also becomes continuous with the external coagulum. This was denominated *bouchon* by PETIT, and constitutes the internal coagulum of JONES. The connexion between it and the external coagulum, and the relation of both of them with the orifice of the divided artery, have been aptly compared by BECLARD, to the mouth of a bottle closed by its cork, and sealed over with wax.

It will be seen from this description, that the internal coagulum is too small to fill the calibre of the artery, except at its base, where, as we have just remarked, it adheres to the inner surface of the vessel, and also becomes continuous with the external coagulum. It is only at the latter point, therefore, that it can exercise much influence in restraining the hemorrhage, and it is consequently much less efficient in accomplishing that object, than the coagulum which forms in the sheath of the artery and the surrounding cellular tissue. In some cases, indeed, no internal plug is developed. Its absence in several cases, we have previously remarked, was adduced by POUTEAU, GOOCH, KIRKLAND, and WHITE, as an argument against the doctrine of PETIT; and it will often be found wanting when a large collateral branch takes its origin near the point at which the trunk of an artery is divided—also when the vessel has been obliterated by ligature, as after amputation, &c. GUTHRIE indeed seems to think, that there is considerable difference between the means by which hemorrhage is arrested in small and in large arteries—that too much influence has been generally attributed to the heart, and that those who have adopted the opinions of JONES, have ascribed too much to the retraction of the artery within its sheath, and have not duly considered the importance of the contraction of the vessel itself. He mentions several cases in which the artery could not retract within the sheath, because it hung pendulous from the wound—yet the bleeding ceased spontaneously in a few minutes. He represents that when an artery of the size of the femoral is divided, it retracts within its sheath, but this retraction is also accompanied by a contraction of the orifice or extremity, which gradually assumes the shape of a Florence oil flask, or French claret bottle. The contraction of the divided end of the artery is confined in the first instance to its very extremity, so that the barrier opposing the flow of blood is formed by this part alone. In proof of this, he states that in one case he cut off the end of the artery at less than the eighth of an inch from the extremity, when it bled with its usual vigour. The contraction of the vessel goes on increasing for the space of an inch, and the inside of the contracted portion is filled up with an internal coagulum, which takes the shape of, and adheres to, the inside of the artery, rarely extending as far as a collateral branch, or under almost any circumstances, beyond a couple of inches. (*Diseases and injuries of the arteries.* p. 246, 247.) BÉRARD, moreover, expresses the opinion, that when the internal coagulum is found much smaller than the calibre of the vessel, it is because the latter was firmly contracted upon it during life, but expands after death. (*Dict. de Méd.* IV. 78.) However this may be, we think the internal coagulum, when it exists, although small, exercises more influence than many have been disposed to allow. If it does not entirely fill the calibre of the artery, it will serve to break the force of the impulse of the blood, and as it besides adheres to the inside of the vessel at the point at which the latter is divided, and is also continuous with the external coagulum, it will form a considerable obstacle to the continuance of the hemorrhage, particularly as its influence will be aided by the contraction of the artery.

These different acts taken collectively, constitute the first step adopted by nature to arrest hemorrhage from divided arteries. The infliction of the injury on the vessel is, however, soon followed by inflammation; the vasa vasorum pour out plastic lymph, which accumulates between the internal coagulum and the surface of the artery, between the latter and its sheath, and even in the meshes of the neighbouring cellular tissue. This material gradually becomes concrete, agglutinates all the parts in which it is deposited, and converts them into a dense, whitish, or greenish-coloured friable mass, in which it is difficult to recognize the different component parts. The adventitious deposit adheres intimately to the inner surface of the vessel, unites it slightly to the coagula, and at the same time establishes a close bond of union between the artery and all the parts situated in the immediate vicinity of the wound. In proportion as the coagulable lymph is effused, the internal coagulum is absorbed, and the vessel continuing to contract, it is found at the expiration of a few days, that by the consolidation of the plastic lymph, and its intimate adherence with the arterial tunics, the whole arrangement is converted into a dense, compact, impervious chord, as far as the nearest collateral branch, which precludes the possibility of the future escape of blood, and diverts the whole of that fluid into the collateral vessels. Finally, by subsequent changes, the whole of the adventitious deposits are removed; the neighbouring cellular tissue has its permeability restored; the remains of the obliterated artery are converted into a dense filamentous band in which no traces of the arterial tunics can be recognized, and the anastomosing vessels are found enlarged and tortuous, and carrying on the circulation as perfectly as it was previously done by the main trunk of the artery itself.

Jones inferred from his experiments, that the same changes take place in the inferior portion of the vessel, or that which is most remote from the heart, as occur in the superior, with this difference only, that its orifice is generally more contracted, and the external coagulum is much smaller than the one which adheres to the mouth of the superior portion of the artery, or that from which the blood flows in its direct course from the heart. (*Op. Cit.* p. 56.) Guthrie, however, has adopted views somewhat different. He asserts that the retraction and contraction of the lower end are neither so perfect nor so permanent, as at the upper end, and that the internal coagulum is in many instances altogether wanting or very defective in its formation; giving rise to a very different result from that which is observable in the upper divided end of the same vessel. (*Diseases and injuries of the arteries.* p. 251.) He represents, moreover, that the lower end of a divided artery is more prone to secondary hemorrhage than the upper; so much so, indeed, that when it occurs after having been arrested for a period of four hours, the bleeding takes place in all probability from the lower end. This may always be known from the darker colour of the blood, and from its flowing out in a continuous stream, and not with any arterial impulse. (*Op. Cit.* p. 248.) Notwithstanding he declares that this assertion is fully justified by extensive observation, we think it ought not to be adopted without considerable qualification. When the wounded artery has a very free anastomosis, as the temporal and occipital, the carotids, the brachial at the bend of the arm, the radial or the ulnar in or near the palm of the hand, the tibial, plantar, &c., it very often happens that two streams of blood escape from the wound even at the time the injury is inflicted, and when this does not take place, there is generally so great a proneness to hemorrhage from the lower end of the vessel some time after the upper has been secured, as often to render it necessary to apply a ligature to both, or to command the lower one by pressure. This accident results from the lower part of the artery becoming filled with blood through the anastomosing branches, and this fluid then regurgitating through the wound. In such cases as these, the observation of Guthrie is not without foundation; but applied to the generality of instances, it is altogether too sweeping in its character, and so far as our own experience has extended, is not justified by facts.

Some pathologists, observing the remarkable tendency of the blood to be diverted into collateral branches, instead of continuing its course along the upper end of one which has been cut across or obstructed, and considering that the capillary vessels possess the faculty of attracting the blood through the medium of the larger arterial branches which convey that fluid, have imagined that this attractive, or as it has been denominated by some, *suction* power of the extreme vessels, exercises an important influence on the changes by which hemorrhage from a bleeding artery is arrested. The disposition of the blood to be diverted from the

wounded portion of the artery into the collateral branches, was long since noticed by Haller. He observed that when he applied a ligature to one of the mesenteric arteries of a frog, the blood contained in the vessel immediately became quiescent, and that numerous globules accumulated along the middle of the vessel, as far as the ligature, without occasioning any distension of its tunics. He discovered, moreover, that the blood no longer entered the portion of the wounded vessel situated immediately above the ligature, nor was the quiescent state of the small quantity already existing there in the slightest degree disturbed, but the whole of the circulating fluid was diverted into the collateral channels. After a short time, indeed, the blood collected above the ligature was also carried away, so that none remained in that situation. (*Opera Minora.* I. exp. 54.) The same phenomena were observed by Kaltenbrunner, in his experiments. He found when he divided the mesenteric artery of a frog, that after the blood had ceased to flow from the wound, it no longer traversed the portion of the vessel included between the seat of injury and the nearest collateral branch, although its lumen was still open and gaping. The blood, when it arrived at the origin of the collateral branches, was deflected at an angle from the calibre of the wounded vessel, into a less obvious route, and occasionally, when a few globules passed from the main current into the empty vessel, they were immediately seen, like an accused criminal, making an effort to return, and unite themselves with the main current. (*Experimenta circa statim sanguinis et vasorum in inflammatione.* Monachii, 1826. Also, Bérard. *Dict. de Méd.* IV.) These facts have been urged as an argument to prove that the capillary vessels attract the blood through the vessels which circulate it, and it has been alleged, that when an artery is divided, this influence being no longer able to act upon the blood through it, but continuing to operate through the collateral branches, that fluid is drawn on through the latter, and that by these changes the cessation of the hemorrhage from the bleeding artery is greatly facilitated. How far any power of the capillaries is capable of exercising such an agency has not been satisfactorily shown, nor is it easy to explain in what manner they attract the blood. By many it has been affirmed, that they possess an active power of expansibility, by which a vacuum is produced, and that this operates on the blood on the ordinary principles of hydraulics. Many arguments might be adduced to invalidate this hypothesis, not the least of which is the well-known fact, that the operation of an irritant upon a part, which always produces an increased determination of blood to the excited capillaries, instead of giving rise to an expansibility of those vessels, occasions them to contract. Such expansibility, if it exist, would besides operate as forcibly on the blood contained in the smaller veins, as it does upon that within the arteries. It is well known, that Koch of Munich, has been for a long time in the habit of dispensing with tieing the arteries after amputation.

It is suggested by his son, that when an artery is tied or divided, the blood itself possesses the faculty of selecting the route it should pursue—and that, therefore, it is not astonishing, it should be capable by some peculiar power or action, of avoiding the open end of the divided artery. (*Journal de Progrès.* III.; and Bérard. *Dict. de Méd.* IV. 80.) This conjecture is too destitute of every thing like a semblance of probability to require examination. The attractive power of the capillaries is, however, so fully proved by a mass of incontestable evidence, that it does not admit of a doubt. It is highly probable, moreover, that it exercises considerable influence upon the cessation or continuance of hemorrhage from wounded arteries. The late Professor Smith, of Yale College, attributed great power to this agency. He supposed that the capillaries are capable of exercising a kind of pumping influence upon the blood, by which they attract it through the arteries, and that one reason why hemorrhage is arrested with so much more facility after amputation, than from wounds of arteries when the limb is not removed is, that in the latter case, this power of the capillaries continues to operate. In corroboration of his conclusions, he adduces several cases of amputation where no hemorrhage followed, notwithstanding the arteries remained patulous and contained no coagula; and to the same end, we might cite numerous facts recently mentioned by Guthrie, where the bleeding ceased spontaneously, even though the vessels projected from the stump. Professor Smith also mentions the cessation of bleeding from the umbilical arteries of the child, as another instance in which the hemorrhage ceases in consequence of the attractive power of the capillary vessels being cut off. (*Surgical Memoirs.* Edited by Nathan R. Smith. p. 187. Baltimore, 1831.)

We feel well assured that this power of the capillaries is capable of exercising considerable influence in preventing the cessation of hemorrhage from wounded arteries, when it continues to operate, as, for example, when amputation is not performed; but we do not think that the faculty itself is resident in any vital expansibility or pumping operation of these vessels. The blood itself being vitalized, a degree of vital affinity exists between that fluid and the vessels by which it is circulated. Whenever, therefore, the capillaries are stimulated, they seem to be capable of attracting a greater quantity of blood than usual, by virtue of the peculiar relationship which exists between them and their fluid contents. (See *Capillaries.*)

6. *Spontaneous cessation of hemorrhage from arteries which have been partially divided.* The occurrences which take place when an artery of considerable size is wounded, differ according to the extent of the injury, its direction as regards the axis of the vessel, the relations of the sheath with the orifice, and other contingent circumstances. Such wounds may be divided into longitudinal, transverse, and oblique; and in the last variety, it will be important to consider them according as one fourth or one third, one half, or three fourths of the vessel are divided; because when the wound is of limited extent, the artery sometimes heals without having its calibre obliterated; but when it extends through three fourths, although the hemorrhage may cease spontaneously, the permeability of the vessel is always destroyed.

A *longitudinal wound* of an artery, of the extent of three or four lines, does not have its lips much separated. John Bell even asserts, that "an artery wounded with a small and slit-like wound, though fairly cut, will yet preserve its pulse, and will not bleed;" and Beclard found in his experiments, that when he divested the femoral artery of its sheath, and made a longitudinal cut in it to the extent of two or three lines, the lips of the wound were seen to be in contact during the diastole of the ventricle, but were separated by a jet of blood during the systole. Such injuries, however, are generally attended at first by considerable hemorrhage, and this may continue until either syncope or death takes place. But if the sheath of the vessel be preserved, the blood, as it flows out, gradually insinuates itself between it and the artery, and forms a considerable thrombus around the orifice;—the stream gradually becomes smaller, and the puncture being finally closed by a mass of coagulum, the hemorrhage ceases entirely. There are generally two circumstances connected with the infliction of the wound, favourable to the development of those conditions which are instrumental in suppressing the hemorrhage. The first is, that the cellular tissue composing the sheath consisting of loose and yielding filaments, that structure is seldom divided to so great an extent as the proper coats of the artery. The second is, the change of position to which the vessel is necessarily exposed under the influence of the impulse of the heart, which tends to destroy the parallelism between the opening in its tunics, and that of the sheath. Both these conditions are peculiarly favourable to the extravasation of the blood between the artery and its investment, where it immediately coagulates, and plugs up the orifice. Hence it is, if the sheath be removed, and the artery then wounded, the animal will generally bleed to death; but if the sheath be preserved, and is merely wounded simultaneously with the vessel, the hemorrhage will often cease spontaneously.

The flow of blood being arrested, inflammation soon supervenes. Coagulable lymph is then deposited in the orifice of the vessel and in the adjacent tissues, the coagulated blood is gradually absorbed, and the concrete lymph forms a kind of plug or excrescence, which completely closes the opening made in the coats of the artery. This is at first very conspicuous, but in process of time it is greatly diminished in size, and if the vessel be examined after the process of reparation has been completed, its inner surface will exhibit merely a linear cicatrix, corresponding to the site of the wound. This capability of an artery to have a wound implicating only a portion of its diameter, healed without destroying its permeability, was known to Petit. He presented to the Academy of Sciences a brachial artery which had been wounded two months previously: the lips of the wound were not united in immediate apposition, but the opening was closed by a plug which adhered to the circumference. This new formation retained its integrity after being macerated in water for two months, and in alcohol two years.

Oblique wounds of arteries of limited extent do not differ materially from those which are longitudinal. The lips of the wound, however, are more separated, and the opening, owing to the elasticity of the middle coat, assumes the shape of an

ellipsis or a crescent. Such wounds always bleed more profusely than those which are longitudinal. This is a necessary consequence of the gaping of the orifice: still, such injuries are capable of being closed without the obliteration of the calibre of the vessel, by the formation of a coagulum, first between the latter and its sheath, and afterwards in the divided orifice of the arterial tunics. The opening in the sheath here, as in longitudinal wounds, is less extensive than that in the proper coats of the artery, and the gradual extravasation of blood destroys the parallelism of the two apertures, and thus impedes the egress of the blood and favours the formation of a coagulum by which it is finally arrested. The place of the coagulum is finally supplied by coagulable lymph, which becomes concrete and forms a solid plug or excrescence in the orifice of the vessel, and completely agglutinates it to the surrounding parts. If the artery be opened some time afterwards, the portion of its inner surface corresponding to the site of the wound, will present a small cicatrix of a lunated figure. (Jones. *Op. Cit.* p. 90.) The spontaneous cessation of hemorrhage from oblique wounds will always take place with greater difficulty, in proportion as the puncture or incision approaches the transverse direction.

Transverse wounds of arteries which do not entirely sever the vessel, are far more dangerous than either the longitudinal or oblique. This arises from the greater separation of the lips of the wound, they being drawn asunder by the elasticity of the vessel. Owing to this, such wounds always assume a round figure—a character of them which was long ago noticed by Wiseman, Petit, Monro, and Haller. It constantly occurred in the experiments made by Jones and Beclard, except when one half or more of the artery was divided, and has been well delineated by Jules Cloquet. (*Surgical Pathology.* Pl. I. fig. 1.)

When an artery of large size receives a puncture or cut, severing its tunics to the extent of one fourth or one third of its diameter, blood is at first projected from the wound presenting the ordinary characters of arterial hemorrhage, and if no attempt be made to arrest it, the bleeding may continue until syncope takes place, or until the animal dies from the loss of blood. This will always happen when the sheath of the vessel is destroyed; but if it should be preserved, inasmuch as the opening in it seldom gapes to the same extent as that in the proper tunics of the artery, the blood will gradually become insinuated between it and the vessel, to a considerable extent above and below the puncture. This will destroy the coincidence between the opening in the sheath and that of the artery; the blood will thus meet with a still greater obstacle to its escape—a more extensive coagulum will be formed, which will finally perfect the closure of the orifice, and prevent the further escape of blood. Inflammation will soon after ensue, coagulable lymph will be poured out, and after the coagulum has been removed by absorption, a firm accretion of organized lymph will be found, closing the orifice of the artery and agglutinating the adjacent parts. Under these circumstances, the wound of the vessel is repaired without destroying its permeability, but the cicatrix which remains is always larger on the inner side of the artery than that which follows either a longitudinal or transverse wound.

Should half the diameter of the vessel be divided, a profuse hemorrhage will ensue, and continue almost invariably until death takes place, unless arrested momentarily by syncope; and even then, as soon as the powers of life are resuscitated, the bleeding is renewed, and leads eventually to a fatal termination. This is owing to the great separation of the lips of the wound, occasioned by the retraction of the divided portion of the elastic coat, which keeps the opening so patulous, that the blood continuing to sweep along the vessel, a coagulum of sufficient extent and firmness to close it cannot be formed. Beclard found in his experiments, that all wounds implicating half the diameter of an artery were fatal from loss of blood, and the same results have been obtained by others who have instituted similar investigations. Professor N. R. Smith very properly remarks, in reference to such accidents,—"if it be true that the capillary vessels and the arteries themselves, are capable of influencing the current of blood along the vessel, it is obvious that the flow of it must be rendered much more impetuous than when the capillaries are entirely cut off from continuity with their trunk, and will therefore very much interfere with the recuperative process." (*Surgical Anatomy of the Arteries.* 2d edit. p. 19. Balt. 1835.) It is possible, however, for hemorrhage to cease from wounds of this kind, notwithstanding all these opposing circumstances. Such an event is nevertheless exceedingly rare,

and can never occur except by the formation of a large coagulum during protracted syncope, or under some favourable concurrence of circumstances; nor can a cure be effected but by the total obliteration of the wounded portion of the vessel.

It may have the semblance of a paradox to assert, that a wound implicating three fourths of the diameter of an artery is less formidable, as regards hemorrhage, than one only dividing one half its extent. Such a conclusion is nevertheless fully supported by the experiments of Jones and Beclard. The reason is perfectly intelligible, when the changes the vessel undergoes on the receipt of the wound are examined. Owing to its great elasticity, and its disposition to retract, as soon as two thirds or three fourths of its diameter are severed, the lips of the wound are drawn widely asunder, and the undivided portion is put upon the stretch and elongated, so as to impart to the vessel the scolloped or beaked appearance of a pen, or the bevelled figure of the mouthpiece of a clarionet. A profuse hemorrhage follows the infliction of the wound, but inasmuch as the proper coats of the artery retract more than the sheath, the divided portion of the latter slightly overlaps the edge of the former, so that the diameter of the artery being diminished immediately above the divided point by the peculiar nature of its retraction, a coagulum is soon formed both exteriorly and within the vessel, by which a temporary cessation of the hemorrhage is secured. Inflammation then supervenes; coagulable lymph is deposited both internally and externally, and in proportion as the coagulum is removed, this becomes consolidated, and completes the obliteration of the vessel, precisely as it takes place when it is entirely divided. It should be remarked, however, that before this is effected, the small portion which was not severed, is generally destroyed by ulceration, and allows the artery above and below the wound to retract more extensively than it would otherwise be capable of doing. In all cases, after the plastic lymph has sealed up the vessel, or the opening made through its coats, if there should be either ulceration or suppuration, granulations are formed, and the part is cicatrized precisely as in other wounds.

These principles have been chiefly deduced from experiments on animals, and although they are to a certain extent applicable to the human subject, they are not sufficiently so to justify a reliance on the powers enumerated in cases of profuse hemorrhage from a large artery. There is, indeed, a very material difference between the properties of the arteries of animals, and of those of man. In the former, they are more elastic and probably more contractile; and in addition to this, the blood of animals coagulates more readily; so that by the concurrent agency of these causes, hemorrhage from their vessels is arrested with greater facility by the spontaneous changes detailed above. Still, it has been shown that under many circumstances, these acts are adequate, even in the human subject, to effect the suppression of hemorrhage from wounded arteries. There are, however, some circumstances which will render such a result difficult, or even impossible. Arteries traversing bones—those which are firmly tied down by a strong aponeurotic sheath, or course through a texture so dense as to fix them firmly in their situation, and such as run upon the boundary of some of the natural cavities, or so closely beneath the skin as to possess a very slight covering, are more unfavourable for the development of those changes by which hemorrhage is suppressed. They are either unable to retract, or owing to the character of the surrounding parts, an external coagulum cannot readily form, and they are thus deprived of two of the most important conditions usually concerned in arresting the flow of blood. The condition of the blood itself also exercises a very important influence on the process. When the individual is robust, and his blood rich in fibrine and albumen, it coagulates more promptly and firmly, and favours the cessation of the bleeding; but when that fluid is thin and watery, possessing but little crassis, only a slight and very loose coagulum can be developed, altogether too feeble to prevent it escaping from the wounded artery. This condition of the fluid may be generated either by previous disease, or by repeated hemorrhage; a preternatural loss of blood always tending to render that which remains much more watery than it is in health. Under either of these circumstances, it rarely happens that the hemorrhage ceases spontaneously; but far more frequently it continues until life is destroyed by the loss of blood. In many cases, moreover, even when the hemorrhage has been temporarily arrested, the barrier set up by nature yields to the natural impulse of the circulation, or it is broken up by some sudden or imprudent movement of the body, and consecutive bleeding takes place, which may either cease spontaneously,

and recur again and again, until life is destroyed, or it may continue without interruption to the same termination. This hemorrhage may take place either from the upper or lower end of the vessel, and without any very important change of texture in the artery or the coagulum. Very often, however, it is a consequence of the development of suppuration or ulceration in the wound, which tends to break up the connexions previously established by the coagulum and the plastic lymph poured out by the inflamed vessels. In many cases the hemorrhage seems to be excited by the development of too much irritation in the wound, creating a preternatural determination of blood to the part; and our own experience fully corroborates a remark made by Professor N. R. SMITH —that the presence of the external coagulum is occasionally sufficient to produce this effect. (*Op. Cit.* p. 20.)

In animals, the plasticity of the blood, and the recuperative powers of the arteries, are so great, that wounds affecting them are not generally followed by the formation of aneurism. It is often the reverse in the human subject. It has been fully demonstrated by PETIT, BECLARD, and others, that wounds affecting only a small extent of the diameter of an artery in man may heal spontaneously, without giving rise to aneurism. But it happens far oftener that this fortunate termination is not secured. Should the external opening be very narrow, or not correspond accurately with the wound in the artery, the blood, instead of escaping, may be driven extensively into the surrounding parts, and the orifice of the vessel not being closed, a *primitive false aneurism* will be the consequence. And should the opening in the artery be closed for a time by a fibrinous concretion and coagulable lymph, the obstacle thus formed may be too feeble to sustain the impulse of the blood after the vigour of the circulation is restored. Under these circumstances, the wound in the sheath and the cellular coat being more perfectly united by coagulable lymph than the other tunics, they may become gradually dilated into an aneurismal sac, constituting what is called *consecutive false aneurism.* (See *Aneurism.*) It should be remarked, however, that this can never take place when more than one half the diameter of the artery is divided, or where it is completely severed, since in all such cases, the calibre of the vessel is always obliterated. For an account of the changes which ensue, when a wound is inflicted simultaneously on an artery and a vein, we must refer to the article *Varicose Aneurism.*

3. *Lacerated wounds of arteries.* These injuries, like those inflicted by puncturing and cutting instruments, may involve the whole of the coats of an artery, all of them being torn through, or they may be confined to the internal coat, or to it and the middle tunic. Such wounds may be produced by a preternatural longitudinal distension or elongation of the vessel, as, for example, in violent efforts to reduce dislocations; by one of the extremities becoming entangled in a piece of machinery, &c.; or they may be inflicted by gun-shot or any obtuse body propelled with sufficient force to produce a laceration of the soft parts. Lacerated wounds of arteries may likewise be produced by the sharp end or spiculæ of a fractured bone, and when they are previously diseased, by any violent effort of a kind to put them preternaturally upon the stretch.

If an artery be elongated with considerable force, but still with less violence than is necessary to tear it asunder, the internal coat being incapable of yielding to as great an extent as the other, will be torn at various points, and if the inner surface of an artery which has been thus treated be examined, it will present numerous fissures extending through the lining membrane, and ranging at intervals partially or completely round the vessel. These cracks or fissures are sometimes closely crowded together, and all of them range transversely as regards the axis of the artery. They render its inner surface rough and uneven, and form so many minute valves or crevices, in which the blood becomes insinuated and coagulates. A small nucleus of coagulum being formed in this manner in each rent, a considerable impediment is occasioned to the free transmission of the blood through the vessel, and as the rudimentary coaguli continually increase in size by gradual accretion, if the artery be one of moderate dimensions, it will by this process be finally filled up, and completely obliterated. In some cases, the insinuation of the blood beneath the edges of the lacerated membrane may dissect it up for some distance, and so far weaken the fibrous coat, as to lay the foundation of aneurism. This will be more particularly apt to occur when the injured vessel is one of large size.

If the extending force be carried still farther, not only the lining membrane, but the fibrous coat also will be lacerated. It may be torn at one or at several points, and the rents may be confined to a portion

of the circumference of the vessel only, or extend entirely round it, each one ranging in nearly a circular direction, or parallel with the fibres. Here nearly the same changes will take place as in the preceding case. Each laceration will form a kind of valve in which the blood will insinuate itself and become coagulated, and the vessel may either be obstructed or obliterated, or the cellular coat will become dilated into an aneurismal sac. The latter occurrence will take place much oftener, however, than when the lining membrane alone is affected, and the great liability of those arteries which are situated in the vicinity of movable articulations, to aneurism, as, for example, the popliteal, may be explained upon this principle;—their coats being previously diseased, the fibrous and internal tunics will be apt to become lacerated under the extending force occasioned by the motions of the joint, and an aneurismal tumour will be produced by the dilatation of the cellular coat.

Finally, the whole of the arterial tunics may be lacerated, the vessel being torn completely across. Under such circumstances, if the artery be entirely free from any close and unyielding adhesions with a part which is fixed and immovable, the two internal tunics give way before the external, and the latter, possessing great extensibility, will have its filamentous tissue very much elongated before it lacerates, and will be drawn out considerably beyond the severed ends of the fibrous and internal coats, assuming at the same time the appearance of two cones, the points of which look towards each other, while their base corresponds to the upper and lower end of the divided vessel. Bompard found in his experiments, that when very large arteries, as the carotid and the crural, are lacerated, the cellular coat extends and tears irregularly into thin shreds of greater or less length. The two internal coats are torn without presenting, to any extent at least, the circular retraction which produces the complete or incomplete obstruction of the canal. In the arteries of middle calibre, as the brachial, radial, cubital, or tibial, two kinds of phenomena are observed: one, depending upon the modifications which the *external* or cellular tunic undergoes; and the other, upon the alterations of the *internal* coats. The external coat, thus, by degrees, drawn and elongated, presents a hollow cone, the base of which corresponds with a point a little above where the internal coats are ruptured, and the summit prolongs itself into a long slender filament; the shape is happily enough compared with the slender cone made by drawing out a *glass tube* whilst heated in the flame of a lamp. By the inflation of an artery thus treated, the cellular prolongation is distended into a small, conical, semitransparent bladder, impervious to the air, unless the inflation has been forcibly made. The *internal* and *middle* coats are torn circularly, but not in a clean manner, having frequently the appearance of small incomplete rings, which are entangled and carried along with the distended cellular tissue. Moreover, these two coats exhibit, near the point where they have been torn, parallel ridges, forming folds in the axis of the artery, having their base towards the ruptured edges of the vessel, thus contributing to diminish its calibre. (Jules Cloquet. *Surgical Pathology.* p. 99. Pl. I. figs. 7 and 8.) Nearly the same results were obtained by Beclard, and more recently by N. R. Smith, as well as several others who have investigated the subject experimentally.

It nevertheless happens sometimes, when the artery is closely adherent to some solid unyielding body, as the head of the humerus in dislocations of that bone, that the cellular tunic, in the act of being torn, is not so much elongated, but severs nearly on the same level with the rupture of the internal and middle coat. In such cases, life is generally destroyed by hemorrhage, the blood being extensively extravasated into the surrounding parts. This accident happened twice to Professor Gibson of Philadelphia, in attempting to reduce ancient dislocations of the humerus. The artery had contracted intimate adhesions with the displaced head of the bone, and was torn across in making the extension which was necessary to effect the reduction. The records of the science contain other instances of the same kind, and as lacerated arteries under other circumstances seldom bleed to a dangerous extent, there must be some peculiarity in these cases, which interferes with those changes by which hemorrhage is arrested spontaneously.

The remarkable immunity of most lacerated wounds from hemorrhage, even when very large arteries have been torn across, has long been known to surgeons. In cases in which the arm has been forcibly severed from the trunk, by becoming entangled in machinery, or the leg has been torn across by a similar accident, little or no bleeding has followed, and the individuals have recovered without the

necessity of tying the arteries. The case reported by Cheselden, of a miller, who had his arm torn from the body in this way, and those which have been published by La Motte, Carmichael, Mussey, and others, where a similar accident occurred, afford a striking exemplification of this truth. The same character, likewise, pertains to gun-shot wounds,—in short, to all injuries in which the arteries have their tunics torn asunder, either by obtuse bodies which contuse them violently, or by preternatural elongation or distension.

This being the case, it is important to know, why it is that lacerated arteries seldom bleed. Various explanations have been offered, but unfortunately most of them are so contradictory, or so little satisfactory, that the question is still surrounded by numerous difficulties. By many it has been affirmed, that arteries do not bleed under such circumstances, because they are stunned or paralyzed by the injury, so as to be incapable of contracting and forcing out the blood. Jones thought that the hemorrhage is arrested in nearly the same manner as in punctured or incised wounds of the arteries. Sir Charles Bell affirms, that when the arm is drawn off by machinery, or torn off by round shot, and the artery lies exposed, hemorrhage does not take place, because the coats of the vessel are killed or injured, and being, in consequence of this, no longer able to preserve the blood fluid, it coagulates within the mouth of the artery and stops the bleeding. He maintains, that whenever the proper relation between the coats of the vessel and the blood is interrupted, that fluid immediately coagulates, and this he assigns as a reason for the arteries being obstructed by coagula in a mortified part, and for the development of lamellated fibrinous concretions in large aneurisms. (*Principles of Surgery.* By John Bell: with Commentaries by Charles Bell. I. 271. London, 1826.) By many, the absence of hemorrhage has been attributed to the violent shock sustained by the nervous system, which is also felt by the heart and arteries, and renders their action so feeble that a coagulum is allowed to form in the bleeding vessel, before the powers of the circulation rally sufficiently to propel the blood from the wound. A more rational explanation is that given by Beclard, Syme, N. R. Smith, and several others, who have investigated the subject with attention. They think, that in consequence of the cellular coat being the last to give way, it is elongated, as described above, beyond the line of rupture of the internal and middle tunics, and forms a conical prolongation either closed or ragged at its extremity, which prevents the blood from escaping, or favours its coagulation, so as to close the extremity of the artery. This conjecture is strongly corroborated by the account of such injuries already given, and is proved by a fact mentioned by Bérard. He states, that an individual was admitted at the Hôpital St. Antoine on account of a contused wound, at the bottom of which the ulnar artery could be seen completely torn asunder. Not the slightest hemorrhage had taken place; but when a very small portion was clipped from the upper and lower extremities of the wounded vessel with a pair of scissors, a jet of arterial blood immediately took place from the wound. (*Dict. de Méd.* IV. 97.) But in addition to the agency performed by the conical prolongation of the cellular coat in restraining the blood, and favouring the formation of a coagulum within, it is very properly observed by Professor N. R. Smith, that the internal coat is fractured transversely at numerous places, so as to present an indefinite number of small fissures, into which the blood of the artery is injected. Blood also probably flows from the ruptured tissue into these fissures, and there commingles with that received from the cavity of the vessel. Coagulation then takes place at these points, commencing first in the cracks of the internal coat, which being rough and uneven, form a favourable arrangement for their firm attachment to the walls of the artery, and prevent them from being dislodged by the impulse of the circulating blood. (*Surgical Anat. of the Arteries.* 2d edit. p. 24.) These rudimentary coagula being once formed and firmly attached to the lacerated surface of the vessel, and the blood not being able to escape with freedom from the wound, in consequence of the end of the artery being closed by the conical prolongation of the cellular sheath, the process of coagulation proceeds more rapidly, until finally an elongated mass is formed, filling up the calibre of the vessel for some distance, and having its numerous radicles firmly implanted in the fissures of the lacerated lining membrane. The deposition of coagulable lymph, and the subsequent coalescence of the artery, are effected by the same changes as in incised or punctured wounds.

But notwithstanding lacerated wounds do not generally bleed, it must not be inferred that they always possess this char-

acter. It too often happens, on the contrary, that the wounded on the field of battle are lost by profuse hemorrhage taking place from such injuries, and even though there may be no bleeding at the time the wound is inflicted, the surgeon should never suffer himself to be lulled into a fatal security; for experience has fully proved, that such wounds are remarkably prone to give rise to secondary hemorrhage. The condition of the parts at the time, it has been shown, is highly favourable to repress the flow of blood; but the barrier thus built up is only provisional; it can only prove efficient for a limited period, and as the vital powers of the vessel, and of the adjacent structures, are often too much impaired by the violence inflicted upon them, to allow of their accomplishing the perfect closure and obliteration of the wounded artery, it frequently happens, that when the sloughing, which is consequent upon such a condition, takes place, the coagulum is dislodged from the orifice, and gives rise to fatal hemorrhage.

4. *Simple contusions of arteries*, without any perceptible solution of continuity of their tunics, do not always give rise to the same consequences. It often happens, when a ball or a cannon-shot has passed in the vicinity of an artery of considerable size, that no bad consequences, so far as the vessel is concerned, ensue for several days. But when the sloughs begin to separate, if the arterial tunics have been severely contused, they are apt to give way, and occasion a fatal hemorrhage, unless the surgeon should be prompt in restraining it by proper means. The reason of this is, that the injury inflicted upon the artery so far destroys its vital powers, as to render it incapable of sustaining the integrity of its structures. Its tissues therefore become inflamed; they are rendered soft and brittle, and when the vitality of the surrounding parts is destroyed, and they slough away, the artery also yields, and pours out blood with a freedom proportionate to its magnitude. In some instances, however, a very different consequence ensues. The coats of the artery are not destroyed by sloughing, but the violent contusion so far impairs its vitality, that the blood within coagulates and closes its calibre, or inflammation takes place, and the obliteration is completed by the conjoint influence of the effusion of coagulable lymph, and the solidification of the blood, precisely as it is accomplished in cases of arteritis arising from other causes. It sometimes happens, indeed, that both the artery and its corresponding vein are obliterated from this cause; and it has been shown by Guthrie, that when this takes place, gangrene is very apt to ensue. It has been observed, moreover, that the same consequence very generally follows wounds severing both the artery and vein, gangrene being much more apt to take place in such cases, than when the artery alone is divided.

The consequences of wounds of the arteries, both immediate and remote, have been so fully mentioned in the course of the preceding observations, that it cannot be necessary to recur to them in this place. The mere division of an artery even of large size, were it not for the consequences involved in a profuse loss of the vital fluid, would be an accident of but little importance. It is this, together with the effects which follow, that constitutes the chief danger of such injuries, because these vessels, unlike the veins, do not so readily take on inflammation in consequence of violence inflicted upon them. It may happen, notwithstanding the conservative powers of nature, which often prove so competent to arrest the bleeding, that life may be destroyed either by the profuse flow of blood externally, or its extravasation into the tissues or one of the natural cavities. Aneurism is another consequence which may follow a wound inflicted upon an artery; and if a vein be wounded at the same time, if there be a correspondence between the openings in the two vessels, the artery may project its blood into the vein, and give rise to varicose aneurism. It happens, moreover, when the main artery of a limb is wounded, that the parts thus deprived of their proper supply of blood, become numb, cold, and devoid of circulation; and if the collateral vessels should not soon become sufficiently free to supply the structures with their due supply of the vital fluid, they will sooner or later fall into gangrene. (See *Obstruction.*) For an account of the manner in which the circulation is restored when a principal artery has been wounded, we must refer to the articles *Ligature* and *Capillaries.*

A knowledge of the fact, that the unassisted powers of nature are often competent to arrest the bleeding from a wounded artery, should not beget a too confident reliance on her resources. They will often fail even under favourable circumstances, and if the surgeon should trust too far to the powers of the system, he will often experienee the mortification of disappointment, and will find in many

cases where the hemorrhage has been arrested temporarily by the means described above, that after a short time, the safeguard set up by nature will be broken down by the impulse of the circulation, or by changes taking place in the wound, and his patient will be destroyed by hemorrhage, unless he should be present to command it by artificial means.

Treatment. The preceding observations show, that the unassisted efforts of nature are sometimes adequate to arrest the flow of blood from wounded arteries. These observations are also important, as indicating the manner in which the bleeding is arrested, thus furnishing useful hints to the surgeon in the application of such means as may be found necessary to fulfil the same end. They are indeed chiefly valuable on this account; for notwithstanding hemorrhage occasionally ceases spontaneously, it would seldom be safe, when a vessel of considerable size has been wounded, to confide in the unassisted resources of the system.

The treatment proper to be employed for the purpose of arresting hemorrhage from wounded arteries, may be divided into provisional or temporary, and those, the operation of which is permanent. They may, besides, be divided into those which prevent the flow of blood from the wound by compressing the injured artery between the seat of injury and the heart, and those which act directly upon the wound itself. The second class of means may be subdivided as follows: 1. Those remedies which promote the contraction and retraction of the orifice of the artery, and thus favour the formation of a coagulum. 2. Those which close the mouth of the divided artery. 3. Compression of the bleeding vessel in the wound itself. 4. Those means which effect the obliteration of the vessel by inducing adhesive inflammation.

Under the first head we have a variety of resources, all of which operate upon one general principle—that of compressing the injured vessel at some point between the wound and the heart. The principal means of this kind are pressure maintained upon the course of the artery by the finger or thumb,—or a variety of mechanical contrivances, as the tourniquet, torcular, artery compressors of different construction, the compress and bandage, and other powers that can be rendered available in arresting the course of the blood along the wounded artery. Such remedies are generally resorted to in cases of emergency, and are seldom employed except as provisional means, to command the flow of blood until those whose influence is permanent, can be adopted. For this purpose, they are exceedingly valuable, but unfortunately they cannot in general be long continued, as they are apt to destroy the vitality of the limb by cutting off its supply of blood, or to give rise to other mischievous consequences of a character to render the long-continued use of them prejudicial and highly improper.

The advantages to be derived from pressure made with the finger or thumb, will depend very much upon the situation of the vessel to which the force is applied. There are many arteries even of large size, so superficially situated, and placed so immediately over bones or other solid points of resistance, that pressure can be easily made upon them, so as to command the most alarming hemorrhage. Such are the arteries of the head, the subclavian, brachial, crural, femoral, and even the common carotid. The same may be said of the radial and ulnar, the palmar arch, and the anterior tibial, where it courses along the anterior part of the ankle, and after it takes the name of dorsal artery of the foot. But when an artery is deeply embedded in soft parts, and is destitute of a solid point of support, the force of the pressure will be so far lost, as to render it too feeble a resource to deserve attention when the bleeding is profuse. The assertion made by John Bell relative to the impracticability of commanding the course of the blood through the large arteries by pressure, has been contradicted by the concurrent experience of all surgeons of the present day, and a majority of the best operators feel so secure in this procedure, that they seldom use the tourniquet during the operation of amputation. It will be useful, therefore, to describe the best method of making pressure upon the principal arteries, either for the purpose of arresting the flow of blood from a wound accidentally inflicted, or during amputation.

Compression of the common carotid artery. From the deep situation of this vessel, and its intimate relations with the pneumo-gastric and sympathetic nerves, and the internal jugular vein, it cannot be so easily compressed as the subclavian artery. Yet in cases of alarming hemorrhage, pressure may be so directed as to command the flow of blood until a ligature is applied. The head should be thrown forcibly backward, and the thumb of one hand, a common seal mounted on a

handle, or a key wrapped with soft linen, fixed upon the course of the vessel on the inner side of the sterno-cleido-mastoideus muscle, while the other thumb is placed on the outer side. The pressure should then be directed backwards, so as to compress the artery against the anterior face of the vertebral column. This operation is, however, always painful, because of the pressure on the nerves, and the constriction of the trachea, and cannot be long endured.

Compression of the subclavian artery. This may be effected at four different points; but the most convenient and secure is, above the clavicle, where the vessel is passing over the first rib, and from between the scaleni muscles. The patient may be either placed upon a low seat or in a recumbent posture. The arm should be drawn downward and forward, and the head inclined to the opposite side. A triangular space will be observed, bounded anteriorly by the sterno-cleido-mastoideus muscle, posteriorly by the trapezius, and inferiorly by the clavicle. The thumb, or instrument used for compression, should be placed upon the internal and inferior part of this space, just on the outer side of the sterno-cleido-mastoideus muscle, where the artery will be felt emerging from between the scaleni muscles, and sweeping over the first rib. By directing the force downward, backwards, and slightly inwards, the vessel can be easily commanded.

Camper recommended the shoulder to be pushed forcibly backwards, and the pressure to be applied in the triangular space between the clavicle, coracoid process, and the upper border of the pectoral muscle. But this method will be found more difficult of execution, and less effectual, than that just described. The artery may also be compressed in the axilla, against the head of the humerus.

Compression of the crural artery can be easily accomplished at the point at which it escapes from the abdomen over the horizontal branch of the pubis, and beneath Poupart's ligament. At this point it will be found midway between the anterior superior spinous process of the ilium and the symphysis of the pubis, where it reposes upon the front of the bone. The individual should be placed upon a table, on his back, in order that the pelvis may have a fixed point of support,—and the leg should be extended. The thumb is then to be fixed upon the vessel at the point designated, and compressed firmly against the horizontal branch of the pubis. This can be easily accomplished in lean subjects, and even in those who are corpulent it is not attended with difficulty.

Pressure made upon any one of these great vessels will of course command hemorrhage from any of the branches given off by them. But their ternary and quaternary divisions may likewise be compressed in various situations, where there is a solid point against which the pressure may be made. But after what has been said, the method of doing this requires no particular description.

The same ends may be obtained by the common *tourniquet* (q. v.), or when that instrument is not at hand, by a common handkerchief tied around the limb, and then twisted by thrusting the end of a stick beneath it. It will be useful before applying the bandage, to place a graduated compress or roll of linen over the vessel, and to adjust a flat piece of horn, wood, or leather, beneath the handkerchief, in order to prevent it from pinching the skin where it is twisted with the stick. Neither of these means, however, admits of more than a temporary employment, for the purpose of commanding the flow of blood until other expedients can be adopted, inasmuch as by the constriction of the entire circumference of the limb, they completely obstruct the circulation, and if long continued, will become exceedingly painful, and finally give rise to great tumefaction and gangrene. The compress and bandage may be employed for the same purpose, but it is equally objectionable. A piece of soft linen or of some other material should be folded so as to form a cone of proper size, the apex of which should then be fixed upon the course of the vessel, and confined by several turns of a roller bandage, thrown around the member with a degree of constricting force sufficient to interrupt the passage of the blood through the artery.

A very simple expedient may be substituted for all these, which is not liable to the same serious objections, because the force only operates upon two opposite points of the limb, and leaves nearly the whole of the collateral circulation free and unobstructed. A graduated compress is first placed over the vessel, and four or five folds of soft linen along the opposite side of the limb. Over each of these, a flat piece of board of five or six inches in length, and about two inches broader than the diameter of the limb, is to be placed,—the one before, and the other behind. The strap of a common tourniquet is

buckled over these and around the limb, and the screw of the instrument turned so as to produce the requisite degree of compression upon the course of the artery. As but little force is generally required to command the flow of blood along the vessel when the apparatus is properly adjusted, this procedure may sometimes be continued until the wounded vessel becomes closed or obliterated. It should not be used to the exclusion of the ligature, or other safer and more effectual means; but under some circumstances, when it has been found difficult to secure the bleeding artery, we have employed it with perfect success. Sir Charles Bell mentions a somewhat similar expedient which he adopted successfully to compress the dorsal artery of the foot. A graduated compress was placed upon the artery, and two flat sticks, eight inches in length, and an inch in breadth, were disposed transversely—the one across the instep, the other across the sole of the foot, the ends of which were tied together, so as to keep up the necessary degree of compression until the wounded vessel ceased to bleed. Either of these plans may be adopted whenever it becomes requisite to compress any of the arteries of the upper or lower extremity, and they will be found applicable to the hand or foot, and to any part of either the leg, thigh, or arm. Great precaution must be observed, however, to have the graduated compress of proper size and shape, and not to use more force than is sufficient to prevent the flow of blood; otherwise great pain and tumefaction will be experienced, and gangrene may ensue.

A variety of artery compressors have been devised, and some of them may be employed with advantage (see *Tourniquet*); but in no case should any of them be relied on to the exclusion of more important means.

The chief reliance must be placed on the second class of means, or those which exert their influence on the orifice of the wounded vessel. The best applications to promote the retraction and contraction of the end of the divided artery are

Refrigerants and *Styptics*. The efficacy of cold in arresting hemorrhage is well known. Very often, when the bleeding takes place from vessels of small size, the simple exposure of the wound to the cool air will arrest the flow of blood. Cold water, ice, or snow, applied to the part, will frequently exercise a prompt influence in this way, and it is often observed after operations, that even arteries of such size as to throw out blood with considerable volume, cease to bleed soon after sponging the wound with cold water. But however prompt the agency of cold may be, it can only be relied on when the hemorrhage proceeds from small vessels; for notwithstanding those of larger size may cease to bleed while under its influence, they will be apt to pour out blood again, as soon as reaction and warmth are developed in the part. The long-continued use of cold may besides prove prejudicial, by establishing a general chill in the enfeebled state of the system, and thus favour the development of dangerous local determinations to the internal organs.

Styptics are more efficacious. Those chiefly employed are, some one of the mineral or vegetable astringents, and various stimulating applications. The sulphates of alumen, zinc, copper, and iron; the acetates of zinc, lead, and copper; the muriates of iron, mercury, &c., may be employed either in solution or powder. Dosils of fine lint imbued in these materials should be introduced into the wound, and confined by a compress. Alcohol, turpentine, diluted muriatic, nitric, sulphuric, pyroligneous, or acetic acids, may be used in the same manner. But perhaps the most effectual agent of this kind is creosote. An Italian nostrum, very analogous in its general characters to the article just mentioned, and known under the appellation of *Aqua Binelli*, has been also much extolled as a hemostatic remedy; but the experiments of Dr. Davy (*American Journ. Med. Sc.* XIII. 252.) and of Professor Graefe (*Journal für Chirurgie und Angenheilkunde.* XX. 47.; and *American Journ. Med. Sc.* XII. 53.) have not confirmed these representations. (See *Creosote*.)

While it cannot be denied that these styptic applications possess the faculty of arresting the flow of blood from small arteries, they should not be employed, except as an indispensable alternative. They always tend to irritate and inflame the wound, and may be thus productive of great mischief. Cases may nevertheless occur in which it may be necessary to resort to them, even at the hazard of their bad consequences. They may be demanded in wounds implicating a number of vessels too small to be secured by ligature, and so situated that the hemorrhage cannot be commanded by pressure or other means. After some operations, moreover, when a number of small ves-

sels continue to pour out blood, they may be resorted to when milder remedies fail to check the bleeding.

Absorbent or *spongy substances*, as finely scraped lint, sponge, &c., may sometimes be employed with advantage for the purpose of arresting hemorrhage. Their agency is chiefly mechanical. The blood becomes entangled in their spongy or filamentous arrangement, where it immediately coagulates, and being retained by the structure of the obstructing substance, it arrests the bleeding. A popular remedy of this kind is the web of the spider. The ancient surgeons employed pellets of chewed paper. We have found nothing succeed so well as scraped leather. The most popular of all the remedies of this class is, the agaric. It was regarded by the older surgeons as a specific; it however possesses no peculiar virtues as a hemostatic agent. Nevertheless it may be sometimes employed with advantage. When any one of the substances mentioned is resorted to, it should be placed as accurately upon the orifice of the injured artery as possible, and so arranged as to fill up the wound of the soft parts over the vessel, when it presents any depth. Slight pressure should then be applied by means of a bandage or other means.

Compression made in the wound, and directly over the opening of the vessel, is a far more effectual means of arresting hemorrhage. Should the wound of the integument be of sufficient extent, it may sometimes be expedient for the surgeon or an assistant to thrust the finger or thumb down to the bottom of it, in order to make pressure directly upon the orifice of the vessel while preparations are making to apply a ligature; and in some cases, the divided artery may be grasped between the thumb and finger, and held until it is properly secured. Should it be determined to rely upon direct pressure, soft lint, sponge, agaric, or some one of the substances mentioned above, should be thrust into the wound, and a graduated compress adjusted over it, to be secured by a bandage. In some cases, when the external wound is very narrow, it may be necessary to dilate it, inasmuch as the intervention of a thick mass of soft parts between the compress and the wounded artery, often so far enfeebles the force employed, as to render it inadequate to produce the desired effect. But should the artery run over the surface of a bone furnishing a solid point of resistance, this precaution will not be necessary, as the pressure under such circumstances may be rendered effectual, even though the compress is not placed in direct contact with the bottom of the wound. Thus, in wounds of the palmar arch, where, in consequence of the dense aponeurosis of the hand, it is difficult to secure the vessel by a ligature, we have succeeded with great ease in commanding the hemorrhage, by placing a solid ball of some substance in the palm, and binding the hand and fingers firmly over it by several turns of a roller bandage. Besides the compress which is applied directly to the wound, it will sometimes be useful to apply another, of an elongated figure, upon the course of the vessel above, in order to interrupt the passage of the blood.

As the presence of the compress in the wound proves a source of great irritation, while the constriction of the bandage creates great swelling and pain, this practice should never be adopted, except when the artery cannot be secured in a ligature; and if resorted to, it will be better to substitute an artery press, where one is at hand, or some one of the expedients mentioned above, for the roller or spica bandage.

The closure, and subsequent obliteration of the wounded artery, may be effected either by torsion, the plug, ligature, or the actual cautery.

Torsion is chiefly applicable to arteries of small size, and cannot be conveniently practised at the bottom of a deep wound. The end of the vessel should be seized and drawn out with one pair of forceps, and then grasped transversely between the blades of another pair, a few lines higher up. Seven or eight turns should then be made with the forceps on the end, so as to lacerate freely the inner tunics of the artery, and twist its cellular coat. The advantages of this method of arresting hemorrhage, and the rules for practising it, will be more fully described in the article *Torsion*.

The *plug* is seldom employed. There are cases, however, in which it is indispensably necessary. The nutritious artery of the tibia, which is divided in amputation, occasionally pours out blood so freely as to render it necessary to plug its orifice. This may be done either with wax, or a small piece of soft wood as recommended by Dr. PHYSICK. The middle meningeal artery is occasionally contained within a complete canal in the substance of the parietal bone, or the groove in that bone in which it is lodged is deeper than natural. Should it be wounded under such circumstances in the operation

of trephining, the hemorrhage might be arrested with a plug. In other cases, the bleeding may be controlled by pressure made from within outward against the bone, by a small stem or plate of metal, bent near its end at a right angle. When an artery of large size, and very much ossified, is wounded, a conical plug of buckskin may be introduced into its orifice, and confined by a properly adjusted compress. Under these circumstances, the fragility of the coats of the vessel is so great, that the direct ligature will cut through them, and when then the orifice can be readily reached, the plug may be advantageously substituted for the indirect ligature, as the buckskin of which it is composed, being an animal substance, will be absorbed, and will not occasion any permanent irritation. Rolls of bougie plaster have been successfully employed for the same purpose, by Chastanet; but this material is much more objectionable than the buckskin.

The *ligature* should be decidedly preferred to any of these means, in all cases admitting of its application. The general doctrines pertaining to this subject will be discussed in the article *Ligature*, and we shall only speak here of the rules to be observed in applying it to the injuries under consideration. In all cases where the surgeon is called upon to treat wounds of arteries which are of sufficient size to pour out much blood, he should first direct his attention to the possibility of tieing the vessel. If the bleeding has ceased spontaneously, the wound should not be disturbed; but if the hemorrhage still continues, the artery should be sought and secured by a ligature. The blood should be sponged away, and the bleeding end of the artery drawn out either with the forceps or tenaculum. Should the wound of the soft parts be deep, as it will immediately fill with blood, and obscure the orifice of the vessel, it will sometimes be useful to compress the artery above, either by the hand or the tourniquet, in order to discover the situation of the vessel by observing the point from which the jet proceeds when the pressure is removed. It may then be seized, drawn out, and secured in a ligature. In some instances, owing to the narrowness of the external wound, this cannot be done. Under such circumstances, an incision of the requisite extent must be made along the course of the artery, in order to admit of its being reached and secured. This rule is of the utmost importance, inasmuch as more injury is often inflicted by fruitless attempts to secure an artery in a narrow wound, than would accrue from extensive incisions. Should the artery be very deep-seated, it will often be difficult to draw it out sufficiently by means of the tenaculum or artery forceps to admit of the application of a ligature. Under such circumstances, the curved forceps and needle devised by Dr. Physick for securing deep-seated arteries may be employed with advantage, or the same end may be obtained by some one of the numerous instruments which have been invented for that purpose. The vessel should be sufficiently isolated from the surrounding tissues to admit of the ligature being applied to it without including them in the noose. Cases may occur, however, where, from the great depth of the vessel, or the nature of its relations, it cannot be sufficiently separated to receive the ligature directly on its tunics. Under such circumstances, it may become necessary to pass a curved needle, armed with a ligature, around it, including within its sweep a mass of the tissues surrounding the artery, which must be comprised with it in the knot. This is what is denominated the *mediate* or indirect ligature. It should never be employed except as a matter of absolute necessity, inasmuch as it is apt, in consequence of the veins, nerves, &c., being included, to excite great pain and inflammation; and it may lead to even more formidable consequences. Another condition demanding the mediate ligature is, extreme ossification or degeneration of the coats of the artery, rendering them too brittle to sustain the constriction of the thread, without the intervention of some other substance.

Sometimes the lower as well as the upper end of the artery pours out blood. When this is the case, both should be tied in the same manner. Indeed, it will be proper to observe this rule, even though there should be no bleeding from the lower end at the time, since it very generally happens after the lapse of some time, in consequence of the freedom of the anastomosing vessels, that the blood passes round into the lower end of the artery, and gives rise to reflux bleeding. This precaution will be doubly necessary when an artery has been wounded in the immediate vicinity of numerous anastomosing vessels; as, for example, near the wrist, the bend of the arm, the ankle, or the knee. Indeed, in all cases when the lower end of the artery can be found without making extensive incisions, or inflicting other serious injury of the soft parts, it will be advisable to secure it as a pre-

cautionary measure against subsequent hemorrhage. The adoption of this rule of practice would often save much pain and trouble, and sometimes obviate very serious consequences. As the ends of the wounded artery cannot retract when the vessel is not entirely severed, in all cases of that kind the artery should be cut entirely across, whether compression, ligature, or any other means of arresting hemorrhage be resorted to.

Silk or animal ligatures may be employed at the option of the surgeon. The latter, however, cannot always be confided in for vessels of large size, as they are apt to become soft and decomposed, before the accomplishment of the adhesive process by which the calibre of the vessel is obliterated. They succeed very well with arteries of medium size; and when a vessel has been wounded pertaining to some protruding organ, which requires to be returned into a natural cavity, they should always be preferred, as the ends can be cut close to the knot, and the noose itself will soon be absorbed. When a silk ligature is employed, one end should be cut close to the knot, and the other brought out at the external opening. (See *Ligature.*) The wound should then be sponged free of blood, wiped dry, and have its edges neatly approximated by adhesive strips, or sutures, according to circumstances. (See *Wounds.*)

Cases sometimes occur in which it is impossible, or difficult, to secure the vessel in the wound. The deep-seated palmar arch, and the plantar arteries, owing to the resistant aponeurosis which covers them, are exceedingly difficult to secure when wounded. They project the blood in the midst of the surrounding parts to such a degree, that when that fluid becomes coagulated, interlaced as it is with firm aponeurotic bands, it will often be impossible to find the wounded vessel in the midst of the confused mass which is thus formed. In such cases, therefore, if the hemorrhage cannot be restrained by pressure, it will be necessary to secure the main artery above the seat of injury. If the tarsal artery be wounded, the posterior tibial should be tied behind the internal malleolus, and if the bleeding continue, pressure must be made on the dorsal artery of the foot, in the manner already directed. When the palmar arch is wounded, it may be necessary to secure either the radial or ulnar artery, according as the injury is more immediately connected with the one or the other. The one that is not tied, must be compressed near the wrist. When a wound is inflicted on the posterior tibial or the fibular artery in the fleshy part of the leg, or on the anterior tibial where it perforates the interosseous ligament, it will be so difficult to apply a ligature to the part of the vessel injured, that it will in general be better to secure the femoral artery high up in the thigh. Wounds implicating the internal maxillary artery will require the ligature to be applied either to the common, or external carotid; and it may become necessary in wounds of the tongue, to tie the lingual artery; or in injuries of the thyroid gland, to secure the artery leading to that body near its origin.

Cautery is another means of arresting hemorrhage which must be sometimes resorted to. It was the chief reliance of the ancient surgeons, and although not so much employed since the discovery of the ligature, it is often a valuable resource when all other means fail. It will be especially demanded in wounds about the mouth, tongue, tonsils, antrum, anus, &c., as in many cases of that kind, the ligature is not available. A cautery button of proper shape should be brought to white heat, and applied quickly to the bleeding vessels, the blood being previously sponged from the wound. It is exceedingly important to have the iron heated to a very high temperature, because in that condition, it immediately kills the parts to which it is applied, and is consequently less painful than when the temperature is less. Under the latter circumstances, it irritates and inflames the structures without destroying their vitality, and in this way, although it may stop the bleeding for the time, it is apt to occasion secondary hemorrhage. (See *Cautery.*)

We do not propose to treat in this place of the various causes of *secondary hemorrhage*, or to indicate the proper treatment to be pursued under all the circumstances giving rise to it. Information upon these points will be found in the articles *Aneurism*, *Ligature*, and *Wounds.* When hemorrhage has been arrested for some time by compression, ligature, cautery, or any one of the means indicated, and recurs after considerable inflammation and change of texture has taken place in the wound, it will seldom be practicable to tie the vessel at the original seat of injury. Any efforts to do so will be attended with extreme suffering, and the artery will, besides, be so agglutinated with the surrounding parts, as to render it impossible to isolate it sufficiently to apply a ligature. Even if this could be done, its tunics

will generally be found so softened by disease, that they will be cut through by the thread as soon as the knot is drawn. Under these circumstances, if the bleeding cannot be commanded by compression, cautery, or some other means, it will be necessary to expose the artery at a proper point above or below the wound, according as the hemorrhage proceeds from the upper or lower end, and secure it by ligature. This procedure will often become necessary after contused wounds of arteries. It not unfrequently happens in injuries of this kind, that the coats of the vessel are so much bruised, that at the expiration of several days they slough away, and give rise to profuse hemorrhage. In all such cases, therefore, the surgeon should enjoin positive quietude, and have a tourniquet buckled loosely on the limb, with instructions to turn the screw in the event of any bleeding taking place. Should hemorrhage ensue, the artery must be exposed and secured by ligature above the wound.

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See also Bibliography of *Aneurism, Wounds, Ligature, Hemorrhage,* and *Torsion.*

§ 6. *Nervous affections of the arteries.* The numerous filaments of nerves which twine upon the surface of the arteries, and form an intricate plexus upon some of their principal divisions, render these vessels susceptible of being influenced by any serious disturbance taking place in the nervous system, especially in its ganglionic portion. But as the nervous affections of the heart are generally manifested in the arteries, it is impossible to discriminate in many cases, between the symptoms which appertain properly to the former, and those which arise from a diseased condition of the latter. Many of the phenomena of disturbed innervation of the arteries are, besides, common to inflammation and other morbid conditions of those vessels. Owing to these causes, and the total absence of those collateral lights which pathological anatomy affords in the investigation of other diseases, our knowledge of the nervous affections peculiar to the blood-vessels is exceedingly meagre and unsatisfactory. As the most important facts pertaining to this subject have been already detailed in the article *Abdominal pulsations* (Vol. I. p. 83.), it will not be necessary to enter into any extensive disquisitions in this place.

1. *Neuralgia of the arteries.* Owing to the obscure sensibility of the ganglionic nerves, from which the arteries derive their chief supply, preternatural irritation of these vessels is seldom attended with much pain. While, therefore, there is reason to infer, that they, in common with other organs, are liable to neuralgic affections, this circumstance explains the absence of that degree of pain and suffering, which characterizes this disease when it seizes upon the sensitive nerves. It rather constitutes a state of organic nervous erethism, indicated by preternatural

pulsation and throbbing of the arteries, which is either local or diffused, according to the extent of the pathological condition. LAENNEC nevertheless affirms, that these vessels are sometimes affected with a neuralgic condition, characterized by pain more or less acute, either continuous or intermittent, following the course of the arteries, and apparently having its seat in the ganglionic nerves with which they are supplied. This pain, he represents, is in general less acute than that which is manifested by the cerebro-spinal nerves, and it is more particularly apt to occur in hypochondriacs and in hysterical females, than in other individuals. (*Auscultation Médiate.* II. 756. Paris, 1826.) It must be confessed, however, notwithstanding this authority, that pain from this cause alone, following the course of the arteries, is an exceedingly rare occurrence.

2. *Preternatural pulsation of the arteries from nervous affection.* A high degree of nervous erethism of the arterial tunics renders them liable to be affected with preternatural pulsations and throbbings, under the influence of a variety of causes, both physical and mental. This condition may exist throughout the whole vascular system, disposing it to be thrown into a general turmoil under the operation of any unusual excitement, or it may be confined to a particular set of arteries. Violent pulsations are often experienced within the abdomen and thorax, in consequence of the aorta and its principal branches being involved in this neuropathic condition, and in some cases, the sympathetic disturbance proceeding from this source is so great, as to threaten serious consequences. In delicate hysterical females, hypochondriacs, and dyspeptics, we have sometimes seen the abdominal pulsations so violent, as to be a source of serious distress and alarm to the patient; and occasionally they seem to be not confined to the abdominal aorta, but are diffused along the branches of the cœliac, the mesenteric, and other arteries distributed to the abdominal organs. When the thoracic portion of the aorta is affected, there is frequently, besides the distressing pulsation and throbbing of the vessel, violent palpitation of the heart, difficult respiration, and a disposition to syncope from the slightest cause. These thoracic and abdominal pulsations are indeed often so energetic, that they are liable to be mistaken for aneurism of the aorta—a mistake which is still more apt to be made, because of this condition of the arteries being sometimes attended with the *bruit de soufflet*, and the *purring tremor* common to aneurism. Numerous examples of a false diagnosis under these circumstances might be cited, in which, after death, notwithstanding the strong indications of aneurism of the aorta which had preceded, dissection revealed no appreciable lesion of that vessel. The carotid and other arteries are not unfrequently affected in a similar manner, and in feeble delicate females of a nervous temperament, who are affected with preternatural erethism of the brain, it is not uncommon to see the carotids and all the arteries of the head pulsating so violently, as to become a source of great distress. Such individuals are indeed sometimes affected with a general perturbation of the whole arterial system under every source of excitement, either mental or corporeal, and in some such we have seen this condition so strongly developed, that they have complained that the throbbing was distressing even at the fingers' ends. A similar condition is very frequently observed during convalescence from protracted fevers, in individuals affected with anemia or other perverted conditions of the circulating fluids, and after excessive losses of blood. In such cases, there is violent throbbing of the arteries, and the heart is affected with distressing palpitations, often giving rise to great sympathetic disturbance of the respiratory function. The pulse has a peculiar full, vibratory, shattered thrill, and a great sense of exhaustion or a disposition to syncope is experienced on taking even slight exercise, or under the influence of any mental emotion. This condition of the circulation, when it has been observed after protracted fevers, has been by some attributed to an inflamed state of the lining membrane of the arteries. We are satisfied, from the result of a close attention to the subject, and the effect of remedies, that it is owing, in a majority of cases at least, to a simple state of nervous erethism of the vascular system, together with a deteriorated state of the blood, which renders it more irritating to the coats of the vessels than in health.

Besides the preternatural excitement and pulsation to which the arteries are liable, when affected with the high degree of nervous erethism under consideration, LAENNEC has affirmed, that they sometimes take on a kind of spasmodic action, which is characterized by the *bruit de soufflet*, and the purring tremor. He represents that the only pathological condition which is constantly associated with

the first of these physical signs, as manifested by the heart and arteries is, a nervous agitation more or less marked, which is in relation with the extent of the sound, or in other words, with the number and volume of the arteries in which it is observed. The *bruit de soufflet* is never perceived in the arteries of an individual affected with open febrile excitement, except the subject possess great nervous mobility. He remarks that when this sign is perceived in the aorta, the carotids, and the arterial trunks of the extremities, simultaneously, the patient is in an extreme state of anguish and anxiety, and if the heart, together with the greater part of the arterial system, present this condition, his life is in peril. When, on the other hand, only one or two arteries are affected, as, for example, the subclavian and carotid, the state of the functions does not always announce a positive condition of disease. The *bruit de soufflet* is very common in a slight degree in hypochondriacs and hysterical females, and in such individuals is particularly manifest in the carotids, the subclavian, and sometimes in the abdominal aorta. He has, besides, remarked the same thing in young and irritable subjects who are greatly disposed to hemorrhage of various kinds; but subjoins, that it is exceedingly rare in individuals affected with open and violent inflammation. In a single case he observed it throughout the whole extent of the aorta of a delicate and irritable child affected with croup, in which it continued two years after convalescenee. That it is purely of a nervous character, and the result of spasm, he infers from the fact, that most of the individuals of the temperament mentioned who are liable to it, seldom present it except in one or two arteries, and in them only at intervals. When they are perfectly tranquil, the stethoscope applied to the carotid, or the subclavian, does not reveal any other sound than that which is natural to the arteries; but the slightest disturbance—walking in a quick pace, coughing, a forcible inspiration, an emotion of pleasure or pain, immediately change the character of the arterial impulse, and in an instant, convert it into the *bruit de soufflet*, which sometimes becomes *sibilant*, but disappears as soon as tranquillity is restored. It may be again induced, however, by compressing the artery slightly with the finger above or below the point to which the instrument is applied, especially if the finger be elevated and depressed alternately. (*Op. Cit.* II. 442.)

These statements are highly interesting, but they are not sufficient to justify fully the inference which has been deduced from them. We are perfectly satisfied, that a state of nervous agitation affecting the heart and arteries is capable of developing both the *bruit de soufflet* and the *frémissement cataire;* yet there is no positive evidence that these phenomena are a consequence of a spasmodic action of the vessels. They may, on the contrary, be induced by various other causes, under particular states of the circulation. We have in several instances discovered *bruit de soufflet* in the arteries of individuals affected with anemia, when the blood was preternaturally watery, and the action of the heart and arteries turbulent and irregular, as it frequently is in that disease. We are inclined to think, that a watery state of the blood, coexisting with preternatural acceleration of the circulation, will very often give rise to the sound in question; and from the phenomena observed in some cases, we have suspected that the *bruit de soufflet* may be frequently produced by the forcible projection of the thin watery blood against the angular prominences which are formed by the bifurcation of the arteries. If, therefore, it may be sometimes an evidence of spasm of the vessels, as supposed by Laennec, it may also owe its existence to other causes, and should not be regarded as conclusive evidence of the presence of that condition.

The causes capable of giving rise to a state of preternatural nervous erethism of the arteries are so numerous, that they cannot be designated. It has been already remarked, that this state often exists during convalescence from protracted fevers. We have repeatedly seen it induced by the imprudent use of mercury; and excessive losses of blood, either by the abuse of venesection, or hemorrhage, almost constantly give rise to disturbed innervation in the circulatory system. Anemia, taking place as a consequence of impaired hematosis; obscure and protracted irritation of the ganglionic nerves, as in dyspepsia; preternatural irritation of the spinal marrow, and an excitable nervous temperament, with a proclivity to hysteria or hypochondriasis, may also be enumerated as causes. It may likewise be induced by the imprudent use of opium, tobacco, and other narcotics.

Treatment. When the impulse of the arteries is much increased, Laennec recommends frequent small abstractions of blood. This practice, however, can seldom

be necessary, except when the morbid erethism of the arteries is associated with hypertrophy of the heart; and if generally followed, it would prove highly mischievous. The majority of cases which have fallen under our observation, have exacted an opposite course. The vegetable and mineral tonics, cool ablutions, or sprinkling the body from time to time with cool water, and, when admissible, the shower-bath, we have generally found to be the most effectual remedies. Of all the mineral tonics, iron is entitled to most confidence; but zinc, copper, bismuth, arsenic, &c., may be employed with advantage. When there is naturally great mobility of the nervous system, it must be soothed by means of sedatives and antispasmodics. Amongst the first class of remedies, prussic acid, acetate of lead, laurel-water, morphia, stramonium, lactucarium, belladonna, camphor, &c., may be selected; and in feeble hystericky females, musk, castor, assafetida, &c., may be occasionally employed with advantage. Proper attention should always be paid to the first passages, and such means employed as to maintain the healthy play of the secretory organs, and secure regular alvine discharges. When practicable, exercise in the open air, change of scene, and recreation of the mind, will be the most valuable remedies, and should not be neglected. Should there be indications of neuralgia, it must be treated according to the principles laid down in the article appropriated to that subject. In some instances, galvanism will be found useful, by restoring the equilibrium between the functional acts of the organs.

§ 7. *Entozoa of the arteries.* No example, as far as we are acquainted, has been reported of an entozoa of any kind having been discovered either within the arteries of the human subject, or in the substance of the tunics of those vessels. It is well known to veterinary surgeons, however, that the arteries of the horse, ass, dog, and some other animals, are remarkably liable to be infested by these parasites. Ruysch long since discovered a bundle of oblong worms, clustered together in the aorta of a horse; and other examples were subsequently described by Morgagni, Schulz, and others, in which similar animals were found in the aorta and mesenteric artery. In more recent times, these entozoa of the arteries have been more particularly noticed by Donald Monro, Rudolphi, Grognier, Hodgson, Chabert, Bremser, Girard, Trousseau and Leblanc, and others. They are particularly apt to take up their habitation within aneurismal tumours affecting the arteries of these animals; but we have also frequently found them forming large packets in the cavities of the heart, especially of the dog. Those which are most commonly enumerated are the *Strongylus Armatus*, and *Strongylus trigonocephalus.* Rudolphi.

F. Geddings.

ARTERIOTOMY. (From αρτηρια, an artery, and τεμνειν, to cut.) Αρτηριατομια, Gr.; *Arteriotomia*, Lat.; *Artèriotomie*, Fr. The opening of an artery for the purpose of blood-letting. (See *Blood-letting.*) It has also been sometimes used to designate that part of anatomy which treats of the dissection of arteries. I. H.

ARTHRALGIA, or ARTHRONALGIA. (From αρθρον, a joint, and αλγος, pain.) Pain in the joints. I. H.

ARTHRITIC. (From αρθρον, a joint.) Relating to gout, gouty. I. H.

ARTHRITIS. (Same derivation.) Inflammation of the joints. (See *Joints, inflammation of; Gout,* and *Rheumatism.* I. H.

ARTHROCACE. (From αρθρον, a joint, and κακος, bad.) This is a generic term, for all diseases of the joints; but it is sometimes restricted to express caries of these parts. I. H.

ARTHRODIA. That species of Articulation which is formed by the head of a bone applied to a shallow socket and allowing of motion in various directions. I. H.

ARTHRODYNIA. (From αρθρον, a joint, and οδυνη, pain.) Pain in the joints. It is more especially applied to slight articular pains, unattended with heat or tumefaction. I. H.

ARTHROPUOSIS. (From αρθρον, a joint, and πυον, pus.) Suppuration of the joints. Cullen gave this epithet to a class of diseases, which he described as characterized by deep, obtuse, durable pains of the joints or muscles, little or no tumefaction, no inflammation, with hectic fever and suppuration of the part. He conceived that in gout and rheumatism, suppuration never occurred, and therefore that those diseases were generically distinct from the affection he wished to designate by the above term. (See *Joints, suppuration of; Gout,* and *Rheumatism.* I. H.

ARTICHOKE. (See *Cinaria.*)

ARTICULAR. Appertaining to the joints. I. H.

ARTICULATION. (See *Joints.*)

ARTISANS, *Diseases of.* (See *Occupations, their influence on health.*)

ARUM. (*Botany* and *Mat. Med.*)

Sex. Syst. Monoecia Polyandria. *Nat. Ord.* Aroideæ.

Gen. Ch. *Spathe* one-leaved, cucullate, convolute at base. *Spadix* naked at the extremity, with sessile anthers in the middle, and ovaries at base. *Berry* one-celled, many-seeded. Beck.

Most, if not all the species of this genus, are endowed with highly acrid and caustic properties, dependent on a very volatile principle, destructible by heat or even the action of the air; it has never been obtained in a separate form, nor is it capable of combining with water, alcohol, ether, or the oils. The officinal species are *A. maculatum*, D.; *A. triphyllum*, U. S.

A. maculatum. Wake Robin. Cuckoo Pint. *Pied de veau*, Fr.; *Aronswurzel*, Germ.

Sp. Ch. Leaves radical, hastate sagittate; lobes deflexed; spadix club-shaped, obtuse, shorter than the spathe. Hooker.

This species is found in most parts of Europe. The root is solid, tuberous, and rounded. When fresh, it contains a milky juice of extreme acrimony, which when applied to the tongue, or to any part of the body denuded of the cuticle, causes a burning heat, which lasts for some hours. When dried, it becomes perfectly inert, and affords an abundant fecula which may be used as a succedaneum for wheat flour, and is sold for that purpose in some parts of England. The volatile principle on which the acrimony of the root depends cannot be obtained on distillation, nor is it contained in the extract, though at the same time these processes deprive the root of all active properties. The root, in a partially dried state, has been given in dyspepsia and in some rheumatic cases, in doses of ten or fifteen grains, three or four times a day. The celebrated French cosmetic, *Poudre de Cypres*, is merely the fecula of this root mixed with some aromatics.

A. triphyllum. Indian turnip. Dragon root.

Sp. Ch. Stemless; leaves ternate; leaflets ovate, acuminate, very entire; spadix clavate; spathe peduncled, ovate, acuminate, convolute below, flat and bent over above. Beck.

The Indian turnip is a native of the United States. It occurs in rich shady woods, or in damp situations, flowering from May to July, and presenting its bright scarlet berries during the summer and autumn. It has a perennial, round, somewhat flattened, tuberous root, covered with a dark, loosely attached epidermis. The leaves are from one to two in number, supported on long sheathing petioles, and composed of three oval or oblong acuminate leaflets. The spathe is cylindrical at base, but expanded and bent over at top; of either a green or purple colour, or of both in alternate stripes. The spadix is cylindrical, bearing the flowers at the base.

The whole plant, and more especially the root, is acrid, and even caustic to the tongue, but scarcely excites rubefaction of the skin. The root has obtained some celebrity in domestic practice as a remedy in some forms of dyspepsia, and more particularly where there is flatulence: it has also been used in rheumatic affections and even in chronic inflammations of the respiratory organs, in which, however, it is more liable to be productive of evil results than to effect a cure, as it is an active stimulant, rapidly increasing the force of the circulation. The fresh roots are too caustic to be administered, and must be kept until they have lost some of their acrimony by the volatilization of the acrid principle. The usual mode of giving this remedy is in powder, with milk, or made into a conserve. The dried roots yield one-fourth of their weight of a pure fecula, closely resembling arrow-root, and forming a good substitute for this article. Boiling also deprives them of any deleterious properties, and renders them esculent.

R. E. Griffith.

ARYTENOID. (From αρυταινα, a funnel, and ειδος, form.) Funnel-shaped.

Arytenoid cartilages. Two cartilages of the larynx. (See *Voice, organs of.*)

Arytenoid glands. Small glands situated anteriorly to the arytenoid cartilages, and which pour out a mucous fluid to lubricate the larynx.

Arytenoid muscle. A small muscle which passes from one arytenoid muscle to the other. (See *Voice, organs of*, and *Muscles.*) I. H.

ASARABACCA. (See *Asarum.*)

ASARUM. (*Botany* and *Mat. Med.*)

Sex. Syst. Dodecandria Monogynia. *Nat. Ord.* Aristolochiæ.

Gen. Ch. *Calyx* three or four-cleft, sitting on the germ. *Corolla* none. *Capsule* coriaceous, crowned. Willd.

1. *A. Canadense.—Canada snake-root. Wild ginger.—Sp. Ch.* "Leaves broad reniform, paired; calyx woolly, deeply three-parted; segments sublanceolate, reflected." Pursh. This species of Asarum has a perennial, long, creeping, somewhat jointed, fleshy, yellowish root, with radicles

of a similar colour. The stem is very short, dividing, before it rises above the ground, into two long, hairy footstalks, each of which supports a broad kidney-shaped leaf, pubescent upon both surfaces. A solitary flower stands in the fork of the stem, upon a hairy pendulous peduncle, and is often concealed under the loose soil or decaying vegetable matter, so that the two leaves with their petioles are the only parts which appear above the ground. The calyx is very hairy or woolly, and is divided into three broad, concave, acuminate segments, with the ends reflexed, of a deep brownish-purple colour on the inside, and of a dull purple, inclining to greenish, externally. The filaments, which are twelve in number, stand upon the germ, and rise with a slender point above the anthers attached to them. Near the divisions of the calyx are three filamentous bodies which may be considered as nectaries. The pistil consists of a somewhat hexagonal germ, and a conical grooved style surmounted by six revolute stigmas. The plant is indigenous, growing in woods and shady places, from Canada to Carolina. Its period of flowering is from April to July. All parts of it have a grateful aromatic odour, which is most powerful in the root. This portion is recognized among the secondary medicines by our national Pharmacopœia, under the name of Asarum.

The dried root of the Asarum Canadense, "as we have seen it in the shops, is in long, more or less contorted pieces, of a thickness from that of a straw to that of a goose-quill, brownish and wrinkled externally, whitish within, hard and brittle, and frequently furnished with short fibres. Its taste is agreeably aromatic and slightly bitter, said to be intermediate between that of ginger and serpentaria, but, in our opinion, bearing a closer resemblance to that of cardamom. The taste of the petioles, which usually accompany the root, is more bitter, and less aromatic." (*U. S. Dispensatory.*) The root was imperfectly analyzed by Dr. Bigelow, who found it to contain a fragrant volatile oil, a bitter resin, starch, and gummy matter. It yields its virtues to alcohol, and less readily to water.

It was naturally inferred from the close resemblance of this species of Asarum to the *A. Europæum*, that it possessed emetic powers; and such is stated to be the fact by several authors whom we have consulted. Dr. Bigelow, however, observes, that the opinion was probably taken from Cornutus, who, in his plants of Canada, informs us, that two spoonsful of the juice of the leaves of the Asarum are found to evacuate the stomach powerfully. But this author referred rather to the European than the American species; and Dr. Bigelow is inclined to think, that if such an operation was really produced by our native plant, it was ascribable to the peculiar irritability of the patient's stomach, which would have caused the same effect to result from an equal amount of any crude vegetable juice; as he has seen the root employed in considerable quantities without giving rise to vomiting or even nausea. (*Amer. Med. Bot.* I. 152.) The root is an aromatic stimulant tonic, having diaphoretic properties, somewhat analogous in its action to the Virginia snakeroot, and applicable to similar cases. Dr. Firth employed it with success in the tetanus of children arising from cold. It is said to be sometimes used by the country people as a substitute for ginger, whence it derived one of the vernacular names by which it is recognized. It may be given in powder or tincture. The dose in substance is twenty or thirty grains.

2. *A. Europæum.—Asarabacca.—Asaret, Cabaret*, Fr.; *Haselwurz*, Germ.

Sp. Ch. "Leaves reniform, obtuse, binate." Linn. *Sp. Plant.* ed. Willd.

This species bears a very close resemblance to the preceding. It is a native of Europe, growing in woods and shady places, and flowering in April and May. All parts of it are active. The root and leaves are recognized by many of the continental Pharmacopœias; the leaves only by those of Great Britain. It is not ranked among the officinal medicines in the United States.

The dried root is about as thick as a straw, quadrangular, knotted and twisted, furnished with fibres on the under surface, brittle, of a grayish colour sometimes inclining to brown externally, whitish or light-brownish internally, of a peculiar not disagreeable odour somewhat like that of pepper, and of an acrid aromatic taste, which leaves for a time a benumbing impression on the tongue. The powder, which is of a grayish colour, excites sneezing when applied to the nostrils. The leaves have little odour, and a taste similar to that of the root, but much weaker, and at the same time bitterish. They afford a yellowish-green powder. Both parts are commonly thought to lose their activity by keeping, and ultimately to become inert; but Geiger states that this result need not be apprehended, if they are kept in a perfectly dry place.

Their virtues are extracted both by water and alcohol, but are dissipated by long boiling. Vinegar is said to render them inert. MM. Lassaigne and Feneulle found in the root a concrete volatile oil, an acrid fixed oil, and a yellow nauseous emetic substance analogous to cytisin, besides other principles of less importance.

Therapeutic use. The root of asarabacca, either fresh or carefully dried, is emetic and cathartic, and by some writers is said to be diuretic. According to Richter, it exercises also a stimulant influence upon the nervous and vascular systems. Snuffed up the nostrils in the state of powder, in the quantity of one or two grains, it produces much irritation attended with sneezing and a copious flow of mucus, which is said to continue sometimes for several days. The leaves have the same properties, but in an inferior degree. Asarabacca was formerly much used as an emetic; but in this respect has been almost entirely superseded by ipecacuanha. It has been recommended in intermittent fever, menstrual irregularities, dropsies, &c. At present, however, it is little employed except as an errhine, in which capacity it may be used advantageously in head-ache, chronic ophthalmia, and paralytic affections of the face, mouth, and throat.

Dose, and mode of administration. The medicine may be given in powder or infusion. The dose as an emetic is from thirty grains to a drachm. The leaves, on account of their greater mildness, are generally preferred as an errhine. Three or four grains may be snuffed up the nostrils every night till the desired effect is produced. They are often mixed with other substances in order to impart to them an agreeable odour. The *Pulvis Asari Compositus*, of the Edinburgh College, consists of three parts of asarabacca leaves, one of marjoram leaves, and one of lavender flowers. It may be used as an errhine in the quantity of five or six grains.

Geo. B. Wood.

ASCARIS. (From ασκαριζω, I leap.) A genus of intestinal worms. (See *Worms*.)

I. H.

ASCITES. (From ασκος, a water sac.) *Hydrops peritonæi. Hydrops abdominis. Abdominal Dropsy.*

Ascites is that form of dropsy in which the effused fluid is accumulated within the cavity of the peritoneum.

Under the term Ascites, most writers include, also, what are denominated encysted dropsies. But as these have, if any, only a very remote relation to dropsy

properly speaking, consisting, for the most part, in an enlargement and morbid change of structure of one or other of the abdominal viscera, as the liver, spleen, ovaries, uterus, &c., connected, in the majority of instances, with the development of hydatids within its tissues, we have excluded them from our definition of ascites, and restrict the latter term to a morbid accumulation of a seriform fluid within the peritoneal sac.

Ascites is one of the most common forms under which dropsy presents itself. It may occur at any period of life from infancy to old age; but is more frequent after than previous to puberty,—and according to our own experience, females are more subject to it than males. A similar statement is made by Hoffman and others.

Symptoms. In perhaps the majority of cases, ascites is the effect or sequel of chronic disease of the peritoneum and abdominal organs; and as it gives rise, at its commencement, to no very peculiar or decided symptoms, it often exists for a considerable time before the patient or his medical attendant is aware of the fact. The first intimation of its actual occurrence is often derived solely from the intumescence of the abdomen, to which the effused fluid, after it has accumulated to a certain extent, gives rise. In certain cases, nevertheless, particularly those occurring in young, robust, and plethoric subjects, and succeeding to the action of cold, to the repulsion of acute eruptive diseases, or to the suppression of some habitual discharge, ascites may occur suddenly and proceed with great rapidity. Thus, Stoll has known it to appear in the course of a few hours after a draught of cold water taken while the individual was in a state of profuse perspiration. (*Prælect. in divers. morb. chron.* 1788.)

Ascites is preceded and accompanied by a great diversity of symptoms, depending upon the extent, seat, and character of the lesions by which it is produced. Thus, all the phenomena resulting from chronic diseases seated within the abdomen are met with in different cases; while in those cases in which the effusion is connected with affections of the heart and large blood-vessels, or with hydrothorax, the symptoms peculiar to these affections will also be present. The phenomena immediately dependent upon the dropsy of the abdomen are confined, almost exclusively, to those resulting from the physical effects of the effused fluid, its weight, namely, and pressure.

In general, as soon as effusion has taken place within the peritoneal sac, the patient complains of a feeling of more or less weight and constriction about the lower portion of the abdomen. His urine is diminished in quantity, and becomes, ordinarily, thick and high coloured, and lets fall a sediment, differing in appearance in different cases. His thirst is increased,—he becomes languid and indisposed to exertion of any kind,—his bowels are generally costive, and the surface of his body is dry and parched.

The sense of weight and constriction, which is always greatest on that side upon which the patient reposes, together with the languor and inertness of disposition, augment with the progress of the disease. There is also increased thirst,—the urine becomes more scant,—the appetite diminishes,—flatulence and colicky pains, sometimes of considerable intensity, are frequently complained of,—the breathing becomes difficult, and the patient is occasionally affected with nausea and vomiting. In proportion as the fluid accumulates within the abdomen, the parietes of the latter become distended. This distension is first perceived at the hypogastrium, but gradually extends from thence, until finally the whole abdomen becomes enlarged, often to an enormous extent. When fully distended, the abdomen forms an ovoid, tense and uniform tumour,—the skin by which it is covered has a peculiar, smooth, shining appearance, and in many cases large distended veins ramify in every direction over its surface. Occasionally the umbilicus is protruded by the pressure of the fluid within, so as to form a tumour of considerable size.

As the distension of the abdomen increases, the pulse becomes small, quick, and frequent,—the skin drier and more parched, and the face assumes a pallid and more or less bloated appearance. In many cases, the patient experiences a sense of pain or soreness when the abdomen is compressed; in others, he complains of an acute fixed pain in some part of that cavity, but more generally, of obscure shooting pains, occurring at irregular intervals.

When the effused fluid has accumulated to such an extent as to carry the intestines into the upper portion of the abdominal cavity, the descent of the diaphragm being impeded by their pressure, the difficulty of respiration becomes greatly increased, and is often attended with a dry irritative cough. The patient is now often unable to lay down without experiencing the most distressing sense of impending suffocation; his sleep is in consequence interrupted, and his strength rapidly diminishes.

Ascites is occasionally attended throughout with febrile symptoms of some intensity; ordinarily, however, the fever is less marked and of a remittent type.

Ascites may occur alone, or it may be complicated with anasarca, hydrothorax, or both. When it is connected with disease of the heart or great blood-vessels, and when it occurs in patients of an extremely lymphatic temperament or who are labouring under considerable debility, at an early period the feet will be found to become slightly œdematous towards evening, while in the morning, on first rising from bed, the face and eyelids are more or less bloated. In other instances, the œdema of the feet is more extensive and continues during the day, often extending to the legs and thighs; and when the tumefaction of the abdomen is at its height, even the whole body may become anasarcous.

When ascites remains entirely free from anasarca throughout the greater part of its course, it is ordinarily dependent upon a lesion of the peritoneum, unconnected with any considerable disease of either of the abdominal or thoracic organs. Even in such cases, however, when the distension of the abdomen has arisen to a considerable height, more or less œdema of the lower extremities is generally produced, no doubt from the pressure of the effused fluid, upon the veins and lymphatics proceeding from those parts.

The intumescence of the abdomen in ascites, is occasionally quickly dispelled and the patient restored to health, by a profuse diarrhœa; by an increased discharge from the kidneys; by a copious perspiration (Bartholet, Tissot, Frank, Quarin. *Journ. Hebdom.* VI.); or by a hemorrhage or vomiting, occurring spontaneously. (*Analen der Med.* IV. 266. Graham, *Edinb. Med. and Surg. Journ.* XVII. Forestus, Withering, Monro, Percival.) A very interesting case of ascites, of thirteen years' standing, is related by Dr. Graves (*Dublin Journal of Med. and Chem. Sc.* Sept. 1834.), which was very quickly dissipated after the occurrence of a profuse mennorrhagia.

In some instances, the swelling caused by the protrusion of the umbilicus has been known to burst and allow the effused fluid to be discharged. (Schenkius, Benevoli, Forestus, Despertes, Mead.) In a few cases, according to Dalmas, the effused fluid finds its way externally, in

consequence of a communication being formed between the peritoneal cavity and that of the intestines. He saw one case of this kind in an infant, followed by a perfect recovery; the patient dying subsequently of a scrofulous affection. Such favourable terminations are, however, extremely rare.

More commonly, as the distension of the abdomen increases, the patient's strength rapidly declines; the functions of the stomach become entirely suspended, while those of the lungs are performed imperfectly and with the greatest difficulty,—the pulse becomes more and more feeble and contracted,—the patient experiences frequent attacks of syncope,—he is affected with constant drowsiness or complete coma, and death finally occurs either from asphyxia or cerebral congestion. A fatal termination sometimes takes place very suddenly and unexpectedly. In other cases, an acute inflammation is developed within the thorax or abdomen, which generally terminates in death, within a very short period. When acute peritonitis supervenes in cases of ascites, the effused fluid is often very quickly diminished in quantity, or entirely removed previously to death. (Broussais. *Phlegmas. Chron.*) Sometimes, but very rarely, the intumescence of the abdomen suddenly disappears, and dropsy of some other cavity is as promptly developed. Andral mentions a case, in which ascites was suddenly replaced by a serous effusion within the brain, by which the patient was quickly destroyed.

The *diagnosis* of ascites is to be derived chiefly from the tense and uniform intumescence of the abdomen, and the fluctuation of the contained fluid, which may readily be detected if a hand be placed upon either side of the tumour, and while one is kept fixed, percussion is made with the other. When, however, the effusion is but small in quantity, it causes no very perceptible tumefaction of the abdomen, nor can a fluctuation be discovered in the manner just referred to. In such cases, Tarral (*Journ. Hebd.* No. 82.) directs the percussion to be made at the lowest part of the abdomen with a single finger, and within an inch or two of the hand applied; or one hand only may be used, percussion being made with the index finger, while the abdomen is compressed with the others. By this means, Dalmas assures us, that he has been enabled to detect very slight degrees of effusion which had escaped all other modes of exploration. In the work of Piorry (*De la Percuss. médiate.*), some interesting observations will be found on the manner of determining the nature and extent of effusions into the peritoneal sac, by means of the pleximeter.

Under ordinary circumstances, the presence of ascites may be determined without much difficulty,—there being few affections of the abdomen, from which it may not be readily distinguished by a cautious examination, in connexion with the history of the case. Frank, it is true, informs us, that an accumulation of urine in the bladder, causing the latter to become distended and rise high into the abdomen, has been mistaken for ascites, and that the operation of tapping has actually been performed under such circumstances. This, however, could only have occurred from gross ignorance or a culpable inattention to the symptoms under which the patient laboured.

A tumefaction of the abdomen may arise from the development of a gaseous fluid within its cavity,—but the phenomena by which it is accompanied are so distinct from those attendant upon ascites, that it is scarcely possible to confound the one with the other affection. Frank nevertheless refers to a case where a fluctuation was apparently detected upon percussion, but in which all the symptoms were caused by the distension of the stomach from gas.

Dropsy of the liver and of the ovaries, as well as the other varieties of incysted dropsy, bear a close resemblance in their leading phenomena to ascites, especially when they are accompanied, as is frequently the case, with an effusion into the peritoneal sac. In incysted dropsy, however, the fluctuation is either very obscure, or not at all distinguishable: when detected, it is confined to a particular part of the abdomen, and is absent at every other, or it is found to exist in different situations corresponding with the changes in the position of the body. The intestines are not situated in the upper portion of the abdominal cavity, as in ascites, but at the side opposite to that on which the greatest amount of tumefaction exists. In cases of ovarian dropsy, however, when the diseased ovary has acquired a large size, the intestines are pressed upwards as in ascites, and a very distinct fluctuation is often perceived upon percussion. But all difficulty in determining the character of the disease is removed whenever the physician has it in his power to acquire an accurate history of its commencement and progress. In incysted dropsy, a

tumour is, in general, first perceived within the abdomen, which often moves from side to side as the patient varies his position. This tumour is at first small, but very gradually augments in size, until finally it fills the whole of the abdominal cavity. The general health of the patient, at the same time, is but little, if at all impaired; the appetite ordinarily continues good; the urinary secretion is undiminished; the bowels are often regular; the cutaneous exhalation natural; until the tumour acquires sufficient size to cause distension of the abdomen, respiration is unaffected, and there is no œdema of the lower extremities, nor the slightest anasarca. In ovarian dropsy, the general appearance of the patient, if we except the tumefaction of the abdomen, is often that of a perfectly healthy individual.

It is impossible, we believe, for any well-informed physician to confound a state of pregnancy with ascites. The diagnosis may, it is true, be involved, occasionally, in some degree of obscurity, when the two occur simultaneously, as is frequently the case. Thus, Mauriceau, Pujos, Smellie, Baudelocque, and the more recent obstetrical writers, record numerous instances of pregnancy attended with abdominal dropsy; and Frank even goes so far as to assert, that he has ascertained from long experience, that dropsy, especially under the form of ascites, is frequently one of the signs of pregnancy, or at least, that hydropic females have a greater tendency to become impregnated at the commencement of the disease, than when in health. Mauriceau and other writers refer to cases in which successive pregnancies were accompanied with ascites. (*Traité des maladies des femmes grosses.* II. 59.) In all cases of intumescence of the abdomen occurring in females, when any doubt exists as to the condition of the uterus, a cautious and skilful examination per vaginam will always enable the practitioner to determine whether pregnancy does or does not exist.

The *autopsical examinations* of patients who have died whilst labouring under ascites, present a very great diversity of lesions in the abdominal and thoracic organs. The parts most commonly found diseased are the peritoneum, the liver, the spleen, the ovaries, the kidneys, the uterus, the heart, and great blood-vessels. The peritoneum is very generally found to exhibit symptoms of chronic inflammation; it often presents an opaque whitish or milky appearance, which has been compared to the effect that would be produced by long maceration in an aqueous fluid. The membrane is frequently thickened; in other cases it is covered with small membranous floculi which adhere to its surface by one of their extremities (Dalmas), or it is beset with innumerable miliary tubercles: it is often injected with blood, and is occasionally covered with an albuminous layer of more or less thickness. Adhesions between those parts of the membrane that are in contact are very commonly observed. The lymphatic vessels of the abdominal cavity are sometimes considerably enlarged; at others, many of them are obliterated. Morgagni relates instances of both these states. The abdominal muscles, in consequence of the distension to which, in many cases, they are for a long period subjected, are found to be pale and reduced in thickness; in other words, in a state of complete atrophy.

While the indications of a morbid condition of the peritoneum are seldom present without being accompanied with a serous effusion, into the cavity of the abdomen, to a greater or less extent, there is no one of the other lesions met with in cases of ascites, which does not frequently occur without the least trace of effusion being present; the latter likewise often occurs without our being able to detect any important morbid change in either of the abdominal or thoracic organs. It is evident, therefore, that the lesions of these organs are only indirectly concerned in the production of ascites; hence it would be an unnecessary labour to enter into a minute detail of them upon the present occasion. It will be proper, however, to say a few words in relation to the fluid effused within the peritoneum. This varies in quantity and appearance in different cases. In some, the peritoneal sac contains but a few pints, while in others it is distended by many gallons. In perhaps the majority of cases, the fluid is colourless or of a light yellowish tint, perfectly limpid and without any decided smell. Upon the application of heat, or the addition of an acid, it partially coagulates. Occasionally, it is of a deep yellow or greenish colour, and still more rarely, dark brown, or even black. In some cases it is turbid, of a milky appearance, and contains more or less albuminous floculi; in other instances it is of the consistency of thick mucilage, or even gelatinous. Cases are recorded in which it is said to have exhaled a highly fetid odour, even when discharged by an operation during the lifetime of the patient. It frequently contains numerous hydatid cysts, which are

likewise found adhering to the surface of the peritoneum, especially where it envelopes the different organs. (SCOUTETTEN'S *Pathol. Anat. of the Peritoneum. Lond. Med. and Phys. Journal.* 1824–5. *Clinique Médicale*, par G. ANDRAL, Fils.)

Pathology. Referring to the general article *Dropsy* for all details in relation to the pathology of ascites, we shall on the present occasion merely advert to the more prominent lesions upon which the production of the disease would appear to depend.

1. Ascites is occasionally suddenly developed, and the abdomen becomes distended with great rapidity. (RUST'S *Magazin.* XXIX. 468.) These cases generally occur in young, robust, and plethoric subjects, either soon after the patient has been subjected to the influence of cold when in a state of profuse perspiration, or labouring under exhaustion from fatiguing labour or exercise; or else, subsequently to the cessation of some habitual evacuation. This constitutes the acute, idiopathic, sthenic or inflammatory ascites of different writers. The effusion into the abdomen in such cases evidently depends upon that particular grade of inflammation, nearly bordering upon the acute, occurring in the peritoneum, which, whenever it takes place in either of the serous membranes, very generally gives rise at an early period to a morbid discharge of a seriform fluid. Few opportunities, however, are presented for autopsical examinations in this variety of ascites, it being, in general, very readily removed under an appropriate treatment. When such opportunities, however, have occurred, some portion of the peritoneum has been found to be morbidly injected with blood, and slightly opaque: in other instances an albuminous exudation of moderate extent has existed; while in others, neither the peritoneum nor abdominal organs have presented any very decided change from their normal condition.

When ascites occurs under the circumstances just referred to, the pulse is usually tense and active, sometimes full, but more commonly contracted. The skin is hot and dry, the tongue white, and the countenance is frequently more or less flushed. The blood exhibits, when drawn, a buffy appearance, and the urine coagulates when heated. There is great restlessness,—wakefulness or disturbed sleep, —a feeling of great anxiety and of fulness or tension about the abdomen. The latter is often sore to the touch: in many instances the patient complains of an obscure pain seated in some portion of it, and in others, of acute shooting pains, occurring at intervals.

To this variety of ascites we may refer those cases which occur in the course or towards the termination of acute inflammatory affections, particularly of the abdominal organs; those which succeed to the repulsion of certain eruptive diseases; to contusions and other injuries of the abdomen (MEAD. *Præcepta et monita medica.* VIII. 30.); and to protracted and difficult parturition. (OSIANDER, STOLL, SELLE, PORTAL.)

2. Ascites is found to occur much more commonly in those who are labouring under some chronic affection of the abdominal organs. This variety of the disease is chiefly met with in persons of intemperate habits,—those who have been long subject to affections of the stomach and bowels, or who have suffered from repeated attacks of intermittent fever, &c.—or those who reside in unhealthy districts or localities, or whose diet is composed principally of unwholesome articles. This constitutes the symptomatic, asthenic or passive ascites of many authors, by whom it is either referred to obstructions of the viscera or to debility.

There can be little doubt that in a few cases, particularly in those connected with certain hepatic affections, an impediment or obstruction to the venous circulation is really present, and that in this manner the effusion is produced,—but in by far the majority of cases no such obstruction can be shown to exist. It is likewise to be remarked, that in persons who have laboured for a long period under very extensive disease of the liver, spleen, uterus, &c., by which complete disorganization of these viscera has been produced, not the slightest trace of serous effusion into the abdomen has taken place. It is hence evident, that no direct connexion exists between the organic lesions above referred to and the production of ascites, when they occur in the same individual. It is only when inflammation has extended from the affected organ to its peritoneal covering (AYRE), that a morbid effusion of serum into the cavity of the abdomen is produced. More or less serous effusion is well known to be the most common attendant on chronic inflammations of the peritoneum (BROUSSAIS); and upon dissection in fatal cases of the variety of ascites of which we are treating, the most unequivocal indications of a chronic phlegmasia of that membrane are almost invariably present. Our view of the pathology of abdominal dropsy connected with

visceral disease, is confirmed by the fact, that the development of acute peritoneal inflammation is not unfrequently, in this variety of ascites, the cause of death, which is likewise the case in well-marked chronic peritonitis. (Broussais.)

The present variety of ascites is always preceded for some time by the phenomena indicative of disease of one or other of the abdominal organs. The effusion takes place slowly, and consequently the tumefaction of the abdomen is effected very gradually. The disease is seldom attended by any very decided febrile excitement; the pulse is commonly neither tense nor active; the temperature of the skin is but little if at all increased; and the countenance is often sallow, or it has even a deep icteric hue. Occasionally, however, the patient experiences in the course of the day a slight attack of fever, preceded by a sense of chilliness. The tenderness of the abdomen upon pressure is less than in the preceding variety; but colicky pains, often of considerable violence, are frequently experienced. The languor and inertness of the patient are strongly marked,—there is ordinarily great depression of muscular strength, and the emaciation of the body is usually very considerable.

3. That dropsical effusion into the cavity of the abdomen is occasionally dependent upon an obstruction to the venous circulation, there can now be very little doubt. The fact was pointed out by Morgagni and the writers who immediately succeeded him,—while Lower, by direct experiment, proved that when the passage of the blood through the veins is arrested, serous effusion results. He tied the inferior cava in animals, and in every case found they became quickly affected with ascites. It is true, that by many highly respectable pathologists, the dependence of abdominal dropsy, in any cases, upon venous obstruction, has been denied, and similar experiments to those of Lower have been performed and no effusion took place; yet, the observations of numerous and cautious observers, of a late date, prove very satisfactorily that an obstruction to the circulation through the veins does very generally give rise to dropsical effusion, and that such obstruction is frequently present in cases of ascites. Thus, Bouillaud (*Arch. Générales.* 1823–24.) found that in the greater number of abdominal dropsies which fell under his notice, connected with disease of the liver, the calibre of the vena porta was more or less contracted, or even obliterated. He likewise states that the obstacle to the free circulation of the blood may occur either in the liver itself, in the trunk of the portal vein, or in one of the principal branches which terminate in it. A similar statement is also made by Reynaud. (*Journ. Hebdom.*) The inferior cava is likewise occasionally found contracted in cases of ascites attended with œdema of the lower extremities. (Dalmas.)

The impediment to the venous circulation giving rise to abdominal dropsy, may, in other cases, occur from disease of the right side of the heart, or of the lungs; and, occasionally, it is probably to be referred to the pressure, upon the ascending cava, of tumours developed within the cavity of the abdomen.

The symptoms of the variety of ascites under consideration, are similar to those of the variety last mentioned. According to Reynaud, when the obstruction occurs in the vena porta, a dilatation of the superficial veins of the abdomen is produced, which statement, if its accuracy shall be established by future observations, is highly important in regard to the diagnosis of those cases. (Stokes. *Clinical Lectures*, in *Lond. Med. and Surg. J.* April, 1834.)

4. The dependence of ascites upon lesions of the kidneys, has been very fully established by Bright, Christison, Gregory, Dance, and Rayer. A very interesting case of this variety of ascites is related by Krukenberg. (*Jahrbücker der Klinik zu Halle.* II. 373.) For further particulars on this subject, the reader is referred to the articles *Anasarca* and *Dropsy*. The symptoms in these cases do not differ materially from those of the two preceding varieties.

Treatment. The treatment of ascites will vary in different cases, according to the nature of the lesions with which the effusion into the abdomen is connected, the extent and period of the disease, and the age, constitution, and habits of the patient.

The morbid accumulation of serum within the peritoneal sac, being merely an effect of some preceding organic affection, it must be evident, that, until the latter is removed, it is in vain to expect a permanent removal of the former. In many, perhaps in the majority of instances, the organic disease upon which ascites depends is incurable, as when a complete change of structure has been produced in the tissues of the heart, lungs, liver, kidneys, &c., or when the cava or other important venous trunk has become greatly contracted or completely obliterated. In

such cases, all that can be done by the aid of medicine is to ameliorate the more urgent symptoms, and in this manner contribute to the comfort of the remaining period of the patient's existence.

In the early stage of nearly all the varieties of ascites, but especially of that denominated acute or idiopathic, *bleeding* constitutes an important remedy. When judiciously resorted to, and carried to a proper extent, it will frequently produce within a short period an increase of the urinary discharge, and a rapid diminution in the intumescence of the abdomen; while, at the same time, it relieves the irritated or inflamed condition of the peritoneum by which the morbid effusion is kept up, and thus prevents a subsequent return of the dropsy.

The beneficial effects resulting from the free abstraction of blood in cases of acute ascites, are pointed out by Backer, Sauvages, Mead, Monro, Portal, and Frank; but its importance is more particularly insisted upon by Rush, Breschet, Geromini, Chauffard, Ayre, Parry, Graham, and the more recent writers. In many cases, it is in vain to expect any decided benefit from the exhibition of purgatives and diuretics previously to free depletion either by the lancet or by the extensive application of cups or leeches over the abdomen. Local depletion, though productive of the best effects in ascites, has been strangely overlooked by the generality of practitioners: in numerous instances a resort to it will supersede the necessity of abstracting blood from the arm; and in all decidedly acute cases, it should invariably follow the use of the lancet.

It is not merely, however, to the acute variety of abdominal dropsy, that the use of general and topical blood-letting is to be restricted. In those cases in which the effusion into the peritoneum is complicated with disease of the heart, or with a chronic affection of some other organ, it will likewise be found often strikingly beneficial. Even when the effusion is dependent upon a permanent obstruction to the venous circulation, bleeding will more effectually check its increase, and relieve the distressing sense of weight and distension under which the patient labours, than almost any other remedy. In such cases, as a general rule, the application of cups and leeches to the abdomen is to be preferred to bleeding from the arm.

Ever since the days of Hippocrates, *purgatives* have been a favourite remedy in ascites; and notwithstanding their denunciation by Fordyce, they are unquestionably beneficial in many cases, particularly such as produce copious watery evacuations, as the neutral salts, gamboge, elaterium, &c. In the acute variety of the disease, when no considerable irritation of the alimentary canal is present, they often prove an excellent adjuvant to bleeding. The purgative which we prefer, under such circumstances, is the cream of tartar in combination with jalap.

Most writers speak favourably of the effects of cream of tartar in nearly all the varieties of abdominal dropsy. (Frank, Jahn, Richter, Ferriar.) When administered in large doses, it not only produces copious fluid evacuations from the bowels, but also an increased flow of urine. Ferriar states that when in his hands the cream of tartar proved successful, its diuretic effects were evinced within twenty-four hours after commencing with its use. He generally found it to diminish the swelling very rapidly; more quickly than the increase in the amount of urine discharged would have led him to anticipate. He was in the habit of administering it in conjunction with digitalis.

Bang and Selig prefer the soluble salt formed by the union of boracic acid with cream of tartar (*Act. Reg. Societ. Med. Havn.* III.); while the favourite prescription of Dr. Physick is the tartrate of potass made by adding one part of carbonate of potass to two of cream of tartar: this we have ourselves employed in several cases of ascites, with decided advantage. The dose is from one to three drachms, every three hours.

As a purgative in abdominal dropsy, Ayre prefers gamboge to all others. He directs it to be given in the dose of from four to five grains triturated with the same quantity of aromatic powder and a small quantity of cream of tartar. We have administered the gamboge in doses of two or three grains combined with a drachm or two of cream of tartar, and have often found it to reduce the swelling in a very short period. It is not, however, well adapted to the acute cases of the disease, and is altogether inadmissible in those attended with any degree of irritation of the stomach or bowels.

Of late years, the elaterium has been extensively employed in ascites. It is confessedly the most powerful hydrogogue we possess, causing a reduction in the size of the abdomen, with more quickness and certainty than any other remedy with which we are acquainted. Like all other very active remedial agents, however, it

requires to be used with great caution. Whenever the bowels are in a state of irritation, the elaterium is a dangerous and improper remedy. The same is also true in all cases, when it is administered at too short intervals, or for too long a period. Hoffman and Sauvages (*Nosol. Méth.* II. 504.) long since pointed out the mischievous effects resulting from the imprudent use of drastic purgatives in ascites. Independently of the violent inflammation of the bowels occasionally produced by them, dropsical effusion into the abdomen so frequently succeeds to a diseased condition of the alimentary canal, that we are persuaded, notwithstanding the rapid decrease in the swelling, which so generally takes place during their employment, they cannot fail to augment, in many cases, the lesions upon which the dropsy depends, and accelerate the fatal termination. By these remarks, we do not wish to be understood as reprobating entirely the employment of active hydrogogue remedies in ascites, but only as cautioning against their indiscriminate and excessive use. In his Hospital facts and observations, Dr. Bardsley has detailed several cases of ascites which were cured by the use of veratrea. In the dose of half a grain, every four hours, at first, and subsequently of one grain twice a day, this substance was found to produce repeated watery evacuations, and in a short time to remove entirely the intumescence of the abdomen. In its effects, the veratrea appears to bear a very close resemblance to elaterium. (*Med.-Chirurg. Rev.* Oct. 1830.)

The Kahinha root, a South American production, has within a few years been strongly urged upon the attention of the profession, as a remedy in the abdominal and other forms of dropsy. It was employed by Dr. Francois in several obstinate cases of ascites, with complete success. (*Gaz. Méd. et Gaz. des Hôpitaux.* 1832.) When given in full doses, the kahinha acts powerfully both upon the kidneys and bowels. Of the extract, from twelve to thirty grains may be given, commencing, however, with small doses, and gradually increasing their strength; or a decoction may be made by boiling, for ten minutes, two ounces of the bark, previously macerated for forty-eight hours, in eight ounces of water. One half of this quantity is to be taken at once, and the remainder in the course of two or three hours. The strength of the decoction is to be increased, subsequently, until it causes a marked augmentation of the urinary and intestinal secretions.

In addition to the articles already mentioned, we may remark, that nearly every other enumerated on our list of purgatives, whether mild or drastic, has, by different writers, been proposed in the treatment of this and the other forms of dropsy. But although Rush refers to two cases of ascites cured by an ounce of castor oil taken in the course of the day, we can, in general, expect but little permanent benefit, excepting from those purgatives which produce copious watery discharges. To procure simply an opening of the bowels, or to relieve them from an accumulation of feces, where hydrogogue cathartics are not thought advisable, calomel or any other mild evacuant may be resorted to; but when our object is to cause a discharge of the effused fluid by acting upon the exhalants of the intestines, these articles can seldom be depended upon.

From the circumstance, already referred to, of ascites having been noticed, in many instances, to disappear after the occurrence of spontaneous vomiting, *emetics* have been resorted to and recommended as an important remedy in its treatment, and numerous imposing authorities might be cited in proof of their efficacy. (Boerhaave, Monro, Sen.) Duverney reports a case cured by emetics, in an individual in whom tapping had been repeated several times,—and a somewhat similar one is cited by Monro. Sœmmering assures us that he has obtained from the use of emetics alone, an almost instantaneous removal of ascites. Itard likewise states that he has seen cases that had resisted the use of drastic purgatives and diuretics, cede to the repeated employment of emetics.

It is in those cases of abdominal dropsy which succeed to the action of cold upon the body, and to the sudden cessation of cutaneous eruptions, that the effects of emetics are said to be the most promptly beneficial.

Of the remediate powers of emetics in ascites, we are unable to speak from our own experience, having never employed them. We have, however, derived the most decided advantage from the employment of nauseating doses of tartarized antimony, in the acute variety of the disease, subsequent to active depletion. Frank, also, gives his testimony in favour of the effects of antimonials, when administered under similar circumstances. We have generally prescribed the emetic tartar

in combination with nitre, and we have reason to believe that its efficacy is thereby increased.

The employment of the *nitre* by itself, as a remedy in acute ascites, has the sanction of some of the most distinguished writers on the disease. Rush states, that by a wine-glassful of a solution of two ounces of nitre in a pint of water, repeated three times a day, he cured two cases of abdominal dropsy; and the late Professor Dorsey considered it to be, in the acute variety of the disease, one of our very best diuretics. (*M. S. Lectures.*) To avoid inconvenience from its use, it is recommended to begin with small doses, which are to be gradually increased; and should it prove ineffectual after being continued for two or three weeks, its further employment is to be relinquished. According to Dorsey, it rarely proves actively diuretic until the dose amounts to three or four drachms in the day.

Nearly every article on the list of *diuretics* has been recommended for the removal of ascites: from few, however, will any permanent good effects be derived. The cream of tartar and nitre appear to be the diuretics best adapted to acute cases; in the more chronic, some benefit will occasionally result from the administration of the digitalis and squill. The digitalis is only adapted, however, to cases of ascites occurring in persons of a lax fibre and pale countenance, and attended with a cold skin and feeble or intermittent pulse. (Withering, Maclean.) By Blackall and Hamilton, it is recommended as peculiarly beneficial in abdominal dropsy succeeding to scarlatina.

A strong decoction of *Chimaphila umbellata* is recommended by Somerville, as powerfully diuretic. Sir Walter Farquhar tried it in a case of ascites, with striking advantage; and Marcet employed the extract of the plant, in the dose of fifteen grains, with the best effects.

The infusion of *horse-radish* is spoken of by many eminent practitioners, as a diuretic of very considerable efficacy. (Heister. *Compend. medicin. pract.* § xviii. 212.) A case of ascites, of long standing, is referred to by Eberle (*Pract. Med.* II. 443.), which was removed in a short time by its use. Schmidtmann states that he has frequently employed the horse-radish, with good effects, in abdominal dropsy, after other diuretics had failed. "It appears to me," he remarks, "that modern practitioners have too much overlooked this powerful remedy in obstinate cases of the disease." (Hufeland's *Journal.* LXX. 71.)

The efficacy of whatever diuretic we may employ, will be greatly increased by the patient making use, freely, at the same time, of diluent drinks, particularly such as have the property of increasing also the action of the kidneys: the best of these are, probably, fresh whey, infusion of parsley-root or of juniper berries; but a long list, in addition to these, present themselves for the choice of the practitioner. Caution should, however, be observed, that in acute cases of ascites, or in those attended with inflammation, and an irritable state of the system, all stimulating fluids be cautiously proscribed.

The production of *diaphoresis* has been proposed as a means of removing ascites, both by the exhibition of internal remedies, and by the use of the warm or vapour bath, or by a bath formed of heated sand or common salt. The warm and vapour baths, when properly timed, will unquestionably be found a beneficial remedy in many cases of abdominal dropsy, especially in such as result from the action of cold (Richter), or which succeed to measles and scarlatina, or to the sudden repulsion of cutaneous eruptions. In the latter cases, Frank considers the warm bath to be one of our most efficient remedies. It will likewise be found beneficial in abdominal dropsies connected with chronic disease of the peritoneum and liver.

Of internal diaphoretics, we can say but little from our own experience, unless we may consider as such, minute doses of tartar emetic, to the remedial effects of which we have already alluded.

In the chronic variety of ascites, especially when attended with soreness of the abdomen and occasional paroxysms of pain, we have found the compound powder of ipecacuanha very generally useful.

By a few writers on ascites, *mercury* has been extolled as a remedy of great efficacy, especially when the effusion into the abdomen is attended with hepatic disease. The recommendation of mercury in these cases, appears to us, however, to be founded altogether upon an erroneous view of the pathology of the disease, and of the operation of the remedy. That cases of abdominal dropsy do occur, in which the alterative effects resulting from a properly conducted mercurial course are decidedly advantageous, we are well convinced; but as a general rule, and when given in large doses, or so as to excite a copious salivation, mercury appears to us

to be a doubtful, often an injurious, remedy in all the forms of dropsy. "Under a salivation," remarks Ayre, "the urine becomes charged with serum. Any condition of the system, therefore, approaching even to a state of salivation, must be injurious, by the tendency it must have to increase that morbid state of the body which is nearest allied to the hydropic one. Hence, the mercurial salivation has been numbered amongst the remote causes of dropsy; and the resemblance between the dropsical and mercurial excitement thus established, by the common resemblance of the urine in these states, goes far to prove this connexion; and it is not improbable, that the mercurial inflammation, when considerable, may survive its specific cause, and degenerate, at length, into the purely hydropic state. When, however, mercury is given in minute doses, so that these its specific morbid effects are not produced, it is capable of becoming highly useful." (*Researches on the nature and treatment of dropsy.*)

Mercurial frictions over the abdomen have been resorted to in ascites, with apparently decided advantage. Laennec informs us, that by their employment he has succeeded in curing cases after the remedies usually relied on had entirely failed. (*Revue Médicale.* Mai, 1824.)

The beneficial effects of *frictions* over the abdomen, with liniments composed of diuretic articles, have within a few years been noticed by various European physicians, by whom numerous cases of ascites are reported, in which an entire cure was obtained by this means. Guibert (*Revue Méd.* Sept. 1828. p. 349.) employed as a liniment, the following: tincture of squill, of digitalis, and of colchicum seed, of each half an ounce, combined with one ounce and a half of camphorated oil. This was rubbed over the abdomen, with a flannel cloth, four or five times in the course of the day; the frictions being continued each time from five to twenty minutes. At the same time, he administered internally a combination of equal parts of squill, digitalis, and nitre.

This plan of treating abdominal dropsy by frictions with diuretic liniments, Guibert considers to be peculiarly efficacious, and he attributes to it, mainly, the successful result of the cases which he details. In all of them, as well as in others subjected to the same plan, the dropsical swelling was removed with striking rapidity. In idiopathic ascites, he is of opinion that it will be almost invariably successful. He, however, remarks, that it should not be resorted to until after the phlogistic condition of the system is reduced by appropriate remedies. Brera and Itard both bear testimony to the diuretic effects produced by the squill when applied by frictions to the skin. By Stœrck, simple oily frictions are highly extolled.

Blisters to the abdomen are unquestionably a useful remedy in many cases of ascites; especially in those dependent upon chronic inflammation of the peritoneum. By a few writers, blisters are directed to be applied to the inside of the thighs, in preference to the surface of the belly. Richter refers to a case in which, when thus applied, they caused the removal of an ascites which had resisted all other remedies.

The application of *pressure* to the abdomen, in the treatment of dropsy of that part, either subsequent to the operation of paracentesis, or previously to this being resorted to, is an old practice, which, though neglected for a long period, has lately been revived, and the evidence presented in its favour, is in the highest degree respectable. Recamier, Husson, Moulon and Godelle de Soissons, have employed it with the most decided advantage. Husson states that he has succeeded in completely removing ascites by pressure alone. (*Ann. Med. Chirurg.*) A case is recorded in the *Annali di Medicina*, for 1827, in which Professor Speranza, of Parma, effected a perfect cure by the same means; and more recently, Bricheteau, in a memoir inserted in the *Archives Générales* for 1832 (XXVIII. 75.), has adduced a number of instances in which its efficacy was strikingly evinced. Under its employment, an increase of the urinary discharge, with rapid diminution of the swelling, is said very quickly to occur. When the effusion into the abdominal cavity is unaccompanied by disease of the thoracic organs, the pressure should be made with a laced bandage, accurately fitted to the body, and extending from the lower part of the chest to the pelvis. According to M. Fenioglio, a cure of ascites is not obtained by means of pressure, without a certain degree of peritoneal inflammation being excited (*Gaz. Méd.* III. 588.); an opinion which, to say the least of it, is extremely hypothetical.

The removal of ascites has been attempted by the introduction of the vapour of wine into the cavity of the peritoneum. In the *Annales de la Méd. Physiol.*, two cases are related, the cure of which is attributed to this plan of treatment. And

L'Homme, in the early part of the year 1827, communicated to the Academy of Medicine at Paris, the history of an obstinate case, in which, after having been subjected to all the usual remedies, without any decided benefit, the disease was permanently removed by the introduction into the abdomen, of the vinous vapour. The latter was repeated sixteen times, at different intervals, without any particular inconvenience to the patient, if we except the production of slight colicky pains. This gentleman resorted to the same plan of treatment in another case, of long standing, but without the least benefit. (*Revue Méd.* 1827.) In the *Annales de la Méd. Physiolog.* for August, 1831, some cases of ascites are related, which were treated by the introduction into the peritoneal cavity, of nitrous oxyde gas: in one, only, was a cure effected.

The above practice is one, we must confess, that we should not feel inclined to follow ourselves, or to recommend to others.

From the erroneous opinion, which at one period so extensively prevailed, that the production of ascites, in common with the other forms of dropsy, is invariably dependent, either directly or indirectly, upon a state of exhaustion or debility, the exhibition of *tonics* was formerly, and by many practitioners even of the present day is, considered to be indispensable to its removal. That under certain circumstances, the cautious administration of tonics will be productive of beneficial results in abdominal dropsy, is admitted; but as a general rule, their use is not indicated; on the contrary, they would in numerous cases be productive of injury. In the commencement and early period of the majority of cases, especially, they would be decidedly prejudicial. The accurate discrimination of the particular circumstances which render the employment of tonics proper, can be made only after close and repeated observation at the bedside of the sick: all general directions on this head would be more liable to mislead than to assist the judgment of the inexperienced practitioner.

To evacuate the fluid accumulated in the abdomen, and thus get rid at once of the swelling produced by it, a very obvious means presents itself, the puncturing, namely, of the abdominal parietes,—an operation which is readily performed, is productive of little or no pain to the patient, and, under ordinary circumstances, unattended with danger. Experience, however, has shown, that although in this manner we can without difficulty remove the effused fluid, the benefit obtained is but temporary, the abdomen becoming again distended, and so rapidly, that the very operation itself would appear to increase the extent of the effusion: hence, it has to be repeated frequently, and each time at a shorter interval. Cheselden, Stœrck, Mead, Scott, Villermay, and other writers (*Edinb. Med. Communic.* VI. 441. *Revue Méd.* July, 1828. *N. Samml. Med. Wahrnemungen.* III. 94.), present cases in which the operation was repeated from forty to sixty times in the same patient; and similar instances have fallen under our own notice. They very clearly prove that the operation, though ordinarily without danger, is productive of no permanent benefit. A resort to it is, nevertheless, strongly advised by many respectable physicians. Fothergill, Hunter, Bertrand, Baker, and Mead, advise, as a means of deriving the greatest benefit from the operation, its employment at an early period of the disease; and cases are recorded by them, as well as by Frank, Dessault, Lenten, Richter, and Schmidtmann, in which a radical cure was thus effected. The entire number of such cases is, however, extremely small: in the great majority of instances, a palliative effect is all that can be anticipated from it. Camper assures us that out of one hundred cases in which the operation of paracentesis was performed by him, he could not refer to more than six which were completely cured; and Portal makes a somewhat similar confession.

Occasionally, in ascites, the protruded navel gives way, in consequence of the pressure from within, and allows the fluid to escape from the abdomen; in this manner a permanent cure has been known to result. Mead (*Monita Medica*) was consulted in a case in which the patient, a female, being in a state of extreme exhaustion, he was deterred from performing the operation of paracentesis, and predicted a fatal termination of the disease: two openings, however, occurring near the navel, from the first, twelve pints of fluid were discharged, and, on the ensuing day, six pounds from the other,—and the health of the patient became perfectly restored. In consequence of these spontaneous cures after ruptures of the umbilicus, Sims (*Mem. Med. Soc. Lond.* IV. 472.) and others have proposed to perforate that part, and to allow the fluid gradually to discharge itself during several days, without introducing a canula. Darwin (*Zoonomia*) has seen this operation performed twice, with less inconvenience, and, he conceives, with more advantage to the

patient, than would have resulted from the ordinary mode of tapping. Two interesting cases are related by Mr. OSWALD (*London Med. and Phys. Journal.* April, 1826.), in which good effects, apparently, resulted from allowing the opening made by the trochar to remain unclosed for some time, so as to permit a constant draining off of the effused fluid.

Although we can but rarely expect a permanent removal of ascites to result from the operation of paracentesis, in whatever way it may be performed, a resort to it is, nevertheless, in many instances, absolutely necessary. When the distension of the abdomen is very considerable, the patient is not only incommoded greatly by the weight and pressure of the contained fluid, but experiences often the utmost distress from the impediment which it presents to the freedom of respiration,—and the relief obtained by drawing off the water is immediate and striking. It is probable also, that the mere distension of the abdomen, not only keeps up and augments the morbid state of the peritoneum, upon which the effusion depends, but prevents, also, to a very considerable degree, the beneficial operation of the remedies administered: thus, RICHTER (*Anfangsgründe der Wundarzneikunst.* V. 124.) and SCHMIDTMANN (*Op. Cit.* p. 77.) both remark that they found the very remedies which previously to the operation produced no good effect, to act, subsequently, most powerfully and beneficially. From these circumstances, therefore, a resort to paracentesis becomes, in many instances, of importance. (See *Paracentesis.*)

By most practitioners, the operation is strongly reprobated in ascites complicated with pregnancy; occasionally, however, to prevent the imminent danger of suffocation with which the patient is threatened, it becomes necessary to resort to it in such cases. SCARPA notices the fact, and recommends that the trochar be introduced between the edge of the left rectus muscle and the margin of the ribs, to avoid injury to the uterus. (*Sulla Gravidanza sussiguita de ascite.* 1827.) That the operation may be performed with perfect safety, notwithstanding the accompanying pregnancy, we have abundant evidence. LANGSTAFF and RUSSEL both cite cases which show this very fully. (*Quarterly Journal Med. Sciences.* Jan. 1824. *Lond. Med. and Phys. Journ.* May, 1827.)

The *diet* proper for a patient labouring under ascites, will vary somewhat, according to the circumstances of each case. It should invariably, however, be light, easy of digestion, and unirritating; and in the acute variety of the disease it should be almost exclusively confined to decoctions of the farinaceous seeds, fresh whey, or toast-water. Care must be taken throughout the disease to guard the patient from exposure to damp and cold, as well as from all sudden transitions of temperature.

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D. F. CONDIE.

ASCLEPIAS. (*Botany* and *Mat. Med.*) *Sex. Syst.* Pentandria digynia. *Nat. Ord.* Asclepiadeæ.

Gen. Ch. *Cal.* small, five-parted. *Corol.* five-parted, reflexed. *Nect.* five-leaved; leaflets opposite the anthers, each producing from its base, a subulate everted process. *Stigma* five-angled, opening longitudinally, depressed. *Pollinia* in five distinct pairs. *Follicles* two-ventricose, smooth or muricate. *Seeds* cornose. BECK.

This genus, which gives its name to a natural order, includes a variety of species differing greatly in their physical qualities. Thus, although the roots of most of them are acrid and stimulating,

in some species they are inert or nearly so. The milky juice with which they abound is also, in most instances, bitter and poisonous, though in a few of them it is sweet, and used as an aliment. Many of them have at different times been employed in medicine, though none of them have been generally recognized as legitimate articles of the materia medica. Two only require particular notice—the *A. tuberosa*, a native of the United States, and the *A.* (*Calotropis*) *Mudarii*, peculiar to India.

It is true that several others of our native species have been experimented upon, and have attained some celebrity; but this has been temporary and local, and unsupported by that decided testimony in their favour, which should always attend the introduction of new articles into the materia medica.

As, however, the *A. Syriaca* and *A. incarnata* have been admitted into the secondary list of the U. S. Pharmacopœia, it becomes necessary to say a few words respecting them. They are both stated to be endowed with expectorant, diaphoretic, and diuretic properties, and to have been successfully employed in asthmatic, catarrhal, and rheumatic affections. Dr. Abijah Richardson, of Medway, in Massachusetts, employed the *A. Syriaca*, to the amount of a drachm a day, in divided doses, in cases of the above-mentioned character, with the happiest results. In all instances, it appeared to exercise an anodyne effect, relieving pain and inducing sleep. (Coxe. *Am. Dispen.*) Dr. Tully, whose experience with our native remedies has been very great, states that the root of the *A. incarnata* may be advantageously administered in catarrh, asthma, rheumatism, syphilis, and verminous affections. The dose is from half a drachm to a drachm. (Bigelow. *Treat. on Mat. Med.*)

Many of the East Indian species have also been resorted to medicinally, as emetics, sudorifics, and antispasmodics, particularly the *A. vomitoria*, *A. volubilis*, and *A. prolifera*. (Ainslie. *Mat. Ind.*)

A. tuberosa. Butterfly Weed. Pleurisy Root.

Sp. Ch. Stem erect, hairy, with spreading branches; leaves oblong-lanceolate, sessile, alternate, somewhat crowded; umbels numerous, forming terminal corymbs. Beck.

This species is found in all parts of the United States, but is most abundant in the southern states. It presents many varieties, one of which, the *decumbens*, having a decumbent stem, and almost linear leaves, was erected into a species by Linnæus. The part used in medicine is the root: this is large, formed of irregular tubers, but sometimes almost fusiform; externally of a yellowish-brown colour, internally white. When recent, it possesses a somewhat acrid, and nauseous taste. In the dried state, it is bitter, but loses its unpleasant flavour. It is readily pulverized, affording a dirty-white powder. It imparts its properties to boiling water.

This root is diaphoretic and expectorant, acting, however, without sensibly augmenting the heat of the surface or accelerating the circulation. In large doses, especially if it be recent, it is cathartic. It has long been a popular remedy in a variety of affections, and has been also employed by many regular practitioners, with great success, in diseases of the respiratory organs. There is the amplest testimony of its powers in these complaints, when administered judiciously. Dr. Chapman states that it is distinguished by great certainty and permanency of operation, and is well suited to excite perspiration in the forming states of most of the inflammatory diseases of winter; and is not less useful, in the same cases, at a more advanced period, after the reduction of action by antiphlogistic remedies. (*Elements of Therapeutics.* I. 351.)

It has also been advantageously employed in acute rheumatism, and in the low states of typhus fever, when other diaphoretics were inefficient or even contra-indicated. Some testimony has also been adduced of its powers in bowel affections. Dr. Eberle found it highly useful in dysentery (*Pract. Med.* I. 216.), and Dr. Parker, of Massachusetts, who employed it for twenty-five years, had the greatest confidence in its powers. (Bigelow. *Med. Bot.* II. 26.) It is also said to be gently tonic, and has been popularly employed in indigestion accompanied with flatulence and pain, whence one of its common names, *wind-root*.

A. (*Calotropis*) *mudarii*. Mũdar. Madár.

Sp. Ch. Stem erect, smooth; leaves opposite, nearly sessile, acute, entire, somewhat cordate at base; calyx very small; corolla campanulate. Buchanan.

The mudar or madar as it is termed by Robinson, Ainslie, and Wallich, is the root of the *A. mudarii*, the *Seifide* of the Hindoo physicians, and not of the *A. gigantea*, as is generally asserted. It appears, however, that the roots of a number

of the asclepiadeæ are known under this name in India, and that they all possess analogous and almost identical properties. (Cassanova. *Essai sur le Madar.*) The part used in medicine is the root. This is perennial, fusiform, branched, of a pale fawn colour externally, wrinkled longitudinally, and covered with a brownish powder which soils the fingers. Internally it is whitish; has little or no smell, but a bitter and slightly nauseous taste. To prepare the mudar, the roots are dug up in April and May, well washed and dried in the open air, till the milky juice with which they abound has become inspissated; the epidermis is then scraped off, and the cortical portion removed for use; this, when well dried, should be kept in close bottles, as it is apt to attract moisture. The powder is of a pale fawn colour. (Duncan. *Edinb. Med. and Surg. Journ.* XXXII. 62.) From an analysis made by Cassanova, it appears to contain, 1. an extractive substance (*Madarine*) soluble in alcohol and water, and which is probably its active principle, 5.00: 2. a resin remarkable for its property of not melting at 212° F., and its slight solubility in alcohol, 4.00: 3. a gum, probably containing some madarine, 8.00: 4. a large quantity of starch: 5. albumine: 6. a little fixed oil: 7. lignin. This agrees with the analysis by Duncan, except that the latter found a greater proportion of madarine, 11.5.

The remedial properties of this article are undoubtedly of a high order, and the concurrent testimony of a number of eminent practitioners shows that it has been eminently successful in the obstinate cutaneous affections so common in tropical climates. Robinson speaks of it in the most exalted terms, in elephantiasis and lepra (*Med. Chirurg. Trans.* X. 31.), and Playfair states that he has found it of the greatest service in lepra, hectic fever, rheumatism, &c. (*Trans. Med. and Phys. Soc. Calcutta.* I. 77.) He gave it in doses of grs. iii. to xii., three times a day, gradually increasing the quantity. Cassanova, who experimented largely with it, confirms these statements. He says that its action is more particularly directed to the skin, increasing the action of the capillaries and absorbents of that tissue. When combined with opium, it acts as a diaphoretic, and in small doses is expectorant and tonic. In large doses it causes nausea and vomiting. Duncan, who made many trials with it in the Royal Infirmary at Edinburgh, states that he has satisfied himself that in every respect its action is so similar to that of ipecacuanha, that this might be dispensed with. He was unsuccessful with it in elephantiasis, but found it highly beneficial in psoriasis and lepra.

Dr. A. T. Thomson is of opinion that in many respects it resembles mercury in its operation on the system, and has proved most beneficial in low states of the habit, indicated by pallidness, emaciation, disordered digestion, &c.: in an opposite condition, it proves decidedly injurious. During its use he also states that the diet should be mild and vegetable. (*Elements Mat. Med.* II. 492.)

Ainslie, from his own observations in India, prefers the dried milky juice to the root; and if the principle described by Duncan and Cassanova be the active ingredient, it is most probable that this juice contains a larger proportion than the dried root. (*Mat. Ind.* II. 486.) Duncan, however, is disposed to think this opinion ill founded, grounded on an analysis of the milk of the *A. Syriaca* by Dr. John, of Berlin, showing that it contained a large proportion of inactive resin.

The *A. gigantea*, which, as has already been stated, has generally been assumed as the plant furnishing the Mudar, is likewise employed in India, and apparently with equal success. It has also been naturalized in the West Indies, where it has been prescribed in the same class of diseases, especially in the French islands, with the happiest results. It is noticed by Browne as very common in Jamaica, where it is known by the name of French Jasmin. It is used in powder, in doses of gr. x. to ℈i., in which doses it proves emetic. The infusion made by pouring ℥viii. of boiling water on ℈iii. of the powdered root, also excites emesis in doses of f℥ii. to ℥iv. In smaller quantities, both preparations act as alteratives and expectorants.

From all that can be gathered on the subject of madar, it appears evident that it is closely allied in its effects to the *Apocynum androsemifolium* (q. v.), which contains, according to the experiments of Drs. Knapp and Griscom, an active principle, analogous if not identical with the Madarine. R. E. Griffith.

ASPARAGUS. (*Bot.* and *Mat. Med.*)

Sex. Syst. Hexandria Monogynia. *Nat. Ord.* Asphodeleæ.

Gen. Ch. *Corolla* six-parted, erect; three inner petals reflexed at the apex. *Berry* three-celled, two-seeded. Willd.

A. officinalis.—*Asparagus.*—*Asperge*, Fr.; *Spargel*, Germ.—*Sp. Ch.* "Stem herbaceous, unarmed, round, erect; leaves

setaceous, usually fasciculate; stipules sub-solitary." This plant is too well known to require description. It is a native of Europe, but has been naturalized in some parts of the United States, and is everywhere cultivated for table use. By the ancients it was employed both as a culinary vegetable, and as a medicine. All parts of the plant are probably possessed of the same virtues; but the roots, young shoots, and berries, are the only portions used.

The *root* consists of a thick, short body, and numerous radicles, about as large as a quill, which proceed from the under surface. In the recent state, it is whitish and succulent; when dried, it is gray, soft, and spongy, without odour, and of a feeble, sweetish, slightly bitter taste. Dulong found in it a bitter extractive matter, a saccharine substance, albumen, gum, an odorous resin, and salts. The *shoots*, before being boiled, have a disagreeable bitterish taste. Their juice was found by Robiquet and Vauquelin to contain, besides albumen, mannite, &c., a peculiar principle, to which the name of *asparagin* has been given, and which has subsequently been discovered in other plants. It is a crystallizable substance, without smell, of a feeble nauseous taste, soluble in water and diluted alcohol, but insoluble in absolute alcohol and ether. Its ultimate constituents are oxygen, hydrogen, carbon, and nitrogen. It is neither acid nor alkaline, but, when boiled in water under pressure, or in an alkaline solution without pressure, is converted into a salt consisting of ammonia and a peculiar acid called *aspartic* (q. v.). A new nomenclature has recently been proposed for proximate vegetable principles possessing these properties, in conformity with which, asparagin is called *asparamid*, and the acid resulting from its decomposition, *asparmic acid*. The *berries* have a disagreeable, sweetish, somewhat acrid taste, and are susceptible of the vinous fermentation.

Effects on the system, Therapeutic use, &c. The root of asparagus was employed as a medicine by the ancients, and is still occasionally used, though seldom in this country. It exerts little sensible influence upon the system; but communicates a peculiar odour to the urine, and is thought to be diuretic. It is prescribed in dropsical complaints, as an adjuvant to more powerful medicines. The form of decoction is usually preferred. From half an ounce to an ounce of the root is boiled in a pint of water, and the decoction employed as a drink, *ad libitum*. The root of asparagus is one of the *species diureticæ*, and a constituent of the *syrupus e quinque radicibus* of the Paris Codex, and enters into various other combinations directed by different European Pharmacopœias. It is said that the roots of the wild plant are preferable to those of the cultivated.

The shoots, when boiled, constitute a pleasant and wholesome aliment, peculiarly useful in consequence of its occurring early in spring, when few other fresh vegetables are attainable. They have been long known to impart a peculiar disagreeable odour to the urine. It has been a question whether they produce this change in the urine merely by affording a new constituent to the blood to be eliminated by the kidneys, or whether they excite the kidneys themselves to an increased and altered action. The experiments of M. Gendrin seem to leave no room for doubt that they are actively diuretic. He gave a syrup prepared from the shoots, to numerous individuals, and found that, in every instance, the urine was increased in quantity. When the syrup was taken in the dose of two ounces, the urine was equal to three times, four times, or even five times the amount of drink employed. At the same time, thirst was experienced by the greater number of persons subjected to experiment, and an increased appetite by all. The diuresis ceased on the day succeeding that in which the syrup was used. In no instance did M. Gendrin observe the odour of asparagus in the urine. (*Gaz. Méd. de Paris.* June, 1833.)

It was formerly supposed that asparagus, when very freely taken as an article of diet, was capable of provoking into action various complaints to which a predisposition might exist. Attacks of hemoptysis, gout, piles, menorrhagia, and bloody urine, have been ascribed by different authors to this cause. But the probability is, that if these effects were really produced by the asparagus, they resulted rather from the immoderate quantity than from any peculiar quality of the food taken. So far, indeed, from possessing any general excitant property, asparagus is by some authors considered as sedative in its influence over the heart, and has been highly recommended in complaints of this organ, and in others attended with an irritated state of the circulation. Broussais speaks very favourably of it in hypertrophy of the heart unaccompanied with phlogosis of the stomach. (*Ann. de la Méd. Physiolog.* XVI, 12.) By some, it

is regarded as a general sedative, and is asserted to have been useful not only in neuralgic affections, but in painful organic complaints, obstinate coughs, and nervous excitement from various causes. It is even said to obviate the effects of coffee, and to prevent the wakefulness which so commonly results from the use of this stimulant. Cases are recorded by M. Cassaignard, in which violent palpitations of the heart, attended with other unpleasant pectoral symptoms, were relieved or cured by this remedy. (*Journ. de Pharm.* XIX. 672.) It is, however, denied by Gendrin that asparagus has any immediate action on the heart. In the numerous cases in which he employed it, he never found the pulse diminished by its use a single stroke. The relief of dyspnœa which it sometimes occasions in cardiac affections, he ascribes to its diuretic operation. A diet of asparagus has been recommended in chronic cases to which the remedy is applicable; but the regulated employment of some preparation in which the inert or merely nutritive portion has been got rid of, is decidedly preferable; especially as, in boiling the shoots, much of their active principle must be extracted by the water. The preparation of the shoots usually employed is the syrup. The following is the formula most in use. Take a sufficient quantity of fresh asparagus, bruise it in a mortar of stone or wood, express the juice, heat this by means of a water bath till the albumen is coagulated; then filter, and to each pound of the juice add thirty ounces of refined sugar; lastly, strain through flannel. (*Dict. de Méd.* IV. 213.) But the syrup prepared in this manner is apt to undergo fermentation, and to become deteriorated by time. In order to obviate this result, M. Latour proposes that the juice filtered after the coagulation of the albumen should be mixed with an equal weight of powdered sugar, and the mixture carefully dried by artificial heat. The inspissated juice thus prepared may be kept in well-stopped vessels, and when wanted for use may be made into a syrup by adding half its weight of water, heating to the boiling-point, and straining. The same author also proposes to treat the parenchyma remaining after the expression of juice, with alcohol, to evaporate the resulting tincture sufficiently, then to add sugar and evaporate to dryness. The extract thus obtained may be mixed with the inspissated juice in the preparation of the syrup. For the particulars of the process, the reader is referred to the *Journal of the Philadelphia College of Pharmacy*, VI. 122.

The syrup of asparagus may be given in the quantity of from half an ounce to three ounces daily. A syrup may be prepared also from the unripe berries, which, from its sensible properties, is probably capable of producing on the system the same effects as that made from the shoots. The author of this paper has employed such a syrup in a case of diseased heart, with apparent advantage. An extract from the berries has also been proposed.

It is stated that another species of asparagus, the *A. acutifolius*, has all the properties of the *A. officinalis*.

Geo. B. Wood.

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I. H.

ASPARTIC or ASPARMIC ACID. An artificial acid, discovered by Henry and Plisson, and produced by the action of certain substances on *asparagin*, now called *asparamid*, as a member of a group of azotized substances denominated *amids*, which are characterized by being converted by strong acids or bases, into *ammonia* and various *acids*. In the case of asparamid, the characteristic change produced by the agents indicated, is into

ammonia and a peculiar acid called *aspartic*.

Aspartic acid is best obtained by acting on asparamid in powder with the oxide of lead, diffused in water at the boiling temperature, as long as ammonia is disengaged. Aspartate of the oxide of lead is formed, which is then to be decomposed by means of a current of sulphuretted hydrogen, for the purpose of throwing down the lead, and liberating the aspartic acid. The liquor is then evaporated to dryness, and the dry mass, treated with boiling commercial alcohol which takes up the acid, and deposites it again on cooling in the form of minute scales.

Properties. This acid possesses no odour, and only a slight acidulous taste. It is soluble in 128 parts of cold water, is more soluble in boiling water, less so in diluted alcohol, and is insoluble in absolute alcohol. Muriatic acid dissolves it more copiously than water, sulphuric acid decomposes it, and nitric acid is without action on it even at the temperature of ebullition. It consists, according to LIEBIG, of five equivalents of hydrogen, eight of carbon, one of nitrogen, and six of oxygen, a composition which corresponds with that of asparamid, *minus* the constituents of ammonia.

Aspartic acid neutralizes bases, forming *aspartates*, several of which have been examined. The neutral aspartates of potassa, soda, ammonia, baryta, lime, and magnesia are soluble in water. That of potassa is deliquescent. The aspartate of ammonia, although agreeing precisely in composition (*isomeric*) with asparamid, is nevertheless not identical with it. The aspartates of lead, protoxide of mercury, and silver are either insoluble or sparingly soluble. The insoluble aspartates are formed by double decomposition, and the soluble ones, by decomposing the aspartate of baryta by the sulphate of the given base. The barytic salt is prepared by treating asparamid with barytic water, and removing the excess of base by means of sulphuric acid.

Aspartic acid has no uses.

FRANKLIN BACHE.

ASPHYXIA. (From α priv. and σφυξις, pulse.) This term, in its original acceptation, means "want of pulse." In this sense, it was used by GALEN and the older writers, and is still occasionally employed by the moderns. It is not many years since Mr. CHEVALIER (*Medico-Chirurg. Trans.* I. 157.) described some suddenly fatal cases of heart affection, under the name *Asphyxia idiopathica*, and we find the term, even at the present day, extended so as to include every variety of suspended animation; but, in its usual acceptation with the best writers, like *apnosphyxia*, it is restricted to cases of apparent death, which result primarily, and principally from the suspension of respiration; whilst *syncope* is commonly applied to death commencing in the heart, and *apoplexy* to the variety which is primarily dependent upon a suspension of the action of the brain. Of late, too, the epithet Asphyxia has been applied to the condition of malignant cholera, marked by pulselessness and other symptoms of collapse,—an extension of application, which the term would scarcely seem to admit of, although many of the phenomena are present, which characterize asphyxia from suspension of the respiratory function.

§ 1. *Asphyxia in general.* Asphyxia, in the sense in which we employ the term, may be produced by any agency that interferes with the due aeration of the blood. No truth is better established in physiology, than that no organ of the animal frame can properly execute its functions, unless it receives a due supply of blood, which has been exposed to the contact of air in the lungs, or in some other organ of the body. Without such supply, the capillary functions fail; secretion, nutrition, and calorification, are no longer duly effected; asphyxia or suspended animation results; and this state becomes converted into positive death, unless steps are taken to effect the conversion of the venous into arterial blood, before the circulation is irrecoverably arrested.

Of the necessity of a due supply of arterial blood, no one now doubts,—but its absence has not always been regarded as the main cause of asphyxia; on the contrary, the common belief has been, that the presence of unconverted, or in other words, of black or venous blood in the tissues is positively deleterious, and that asphyxia is caused rather by its presence in the vessels, than by the absence of blood possessing arterial qualities.

Assuming, for the present, that the former of the opinions is the more correct, it will be obvious, that mechanical or other impediments, which interfere with the necessary contact between the blood in the pulmonary vessels and atmospheric air, or air necessary for producing the conversion of venous into arterial blood in these organs, will be the cause of asphyxia.

Accordingly, any agency, which prevents the due expansion of the chest, by

pressing upon its parietes,—as in the punishment occasionally inflicted by the Turks on their prisoners, which consists in burying them up to the neck in earth or sand, and pressing the earth firmly around them,—or, as in that which has been directed by the tribunals of more civilized countries, by placing weights on the chests of the wilfully mute,—will prevent the due quantity of air from entering the lungs, and induce a most painful form of asphyxia. In the latter case, breathing might, for a time, be accomplished by the diaphragm; but in the former, even this imperfect respiration is prevented by the firm pressure of the earth on the abdominal parietes, which necessarily prevents any descent of the diaphragm.

It is obvious, too, that any disease, which mechanically interferes with the due elevation of the ribs, must produce more or less of this effect; as where water, or air or other fluid is effused into the cavity of the thorax, constituting the affections respectively known by the names *hydrothorax*, *pneumothorax*, and *pyothorax;* or where the lining membrane of the chest—the pleura—is inflamed, so that elevation of the ribs, or any attempt at elevation, excites intense pain. In the last case, however, the obstructed aeration is not as strongly manifested, owing to respiration being still carried on, although imperfectly, by the diaphragm.

Another cause of asphyxia is the insufficient supply, or total absence, of oxygen in the inspired air. Hence, extremely rarefied air, and various gases, which are not of themselves positively deleterious, may become negatively so. Unless the air contains a due quantity of oxygen, and that properly diluted by nitrogen, the change of the venous blood into arterial cannot be effected. In atmospheric air alone we find the admixture of these gases in the requisite proportion. Unless this air be supplied in proper quantity, the beneficial conversion cannot be sufficiently effected, and asphyxia may equally ensue.

The negatively injurious gases are,—hydrogen and azote, to which carbonic acid has been added by some (ROGET. Art. *Asphyxia*, in *Cyclopædia of Pract. Med.* I. 167.), but its lethiferous influence is exerted in a somewhat different manner. The hydrogen and azote are capable of being respired for a short time, and they destroy, simply because they do not contain oxygen; but carbonic acid, as well as various other gases, in a concentrated state, cannot be breathed at all, producing, the very instant any attempt is made to inhale them, a spasmodic closure of the glottis. They belong, therefore, to a third set of causes, comprising those that produce asphyxia in consequence of their forming media that are incapable of being inhaled.

The irrespirable gases are, carbonic acid, ammoniacal gas, muriatic acid gas, deutoxide of azote, nitrous acid gas, and chlorine. Different writers have classed under the same head, oxygen, carbonic oxide, protoxide of azote, carburetted hydrogen, sulphuretted hydrogen, and arsenuretted hydrogen; but these gases give rise to no symptoms resembling asphyxia. They are *positively* deleterious, and the only difference between their action and that of other poisons is, the part of the economy through which they make their impression. Their consideration, therefore, properly falls under the head of *Poisons.* They are capable of being breathed: they produce a train of morbid phenomena, which, in the case of some of the gases, rapidly succeeds, even if the gas be only allowed to come in contact with the skin, and they are no more the cause of asphyxia, than would be the vapours of arsenic, or of the deadly hydrocyanic acid, if inhaled.

A last set of causes are those, which mechanically prevent the entrance of air into the pulmonary organs, whether such obstacle be seated externally or internally. To this set belong—hanging; strangulation, and every variety of smothering; obstruction of the air passages by the entrance of extraneous bodies, by the pressure of tumours, or by any morbid thickening of the lining membrane of the tubes. Any disease, too, which gives occasion to the effusion of blood or other fluids into the minute bronchial ramifications, and thus prevents the air from exerting its necessary action on the blood, produces death in this manner. Direct or indirect irritation, or paralysis of the pneumogastric nerves, causes asphyxia, and death, partly in this way, and partly by impairing the powers of the respiratory muscles. It has been long an interesting topic of inquiry to discover the effect of depriving the respiratory organs of their nervous supply from the encephalon. The only encephalic nerves they receive are the pneumogastric or eighth pair of WILLIS, which, as their first name imports, are distributed to both the lungs and the stomach. The division of these nerves early suggested itself to physiologists, but it is only in comparatively recent times, that

the phenomena, resulting from such division, have been accurately appreciated. The operation seems to have been practised as far back as the time of RUFUS the Ephesian, and was afterwards repeated by CHIRAC, BOHN, DUVERNEY, VIEUSSENS, SCHRAEDER, VALSALVA, MORGAGNI, HALLER, and many other eminent investigators of the animal economy. It is chiefly, however, in very recent times, and mainly by the labours of DUPUYTREN, DUMAS, DE BLAINVILLE, PROVENÇAL, LEGALLOIS, MAGENDIE, BRESCHET, HASTINGS, BROUGHTON, BRODIE, and WILSON PHILIP, that the precise effects upon the respiratory and digestive functions have been determined.

When the pneumogastric nerves are divided in a living animal, on both sides at once, the animal dies more or less promptly,—at times, immediately after their division; but sometimes it lives for a few days; MAGENDIE says, never beyond three or four: but this differs in different animals, and does not apply universally to the same animal. A dog, in which M. SÉDILLOT divided the nerves of both sides, lived upwards of two months. (BÉRARD. Art. *Asphyxie*, in *Dict. de Méd.* 2de édit.) As regards the larynx, precisely the same effects are produced by dividing the trunk of the pneumogastric nerve, above where it gives off the recurrents that proceed to the larynx, as by the division of the recurrents themselves: the muscles, whose function it is to dilate the glottis, are paralyzed; and consequently, during inspiration, no dilatation takes place; whilst the constrictors of the glottis, which receive their nerves from the superior laryngeal, —branches given off from the pneumogastric above the point of section,—preserve their action, and close the glottis, at times so completely, that the animal dies immediately from suffocation. But if the division of these nerves should not induce instant death in this manner, a series of symptoms succeeds, considerably alike in all cases, which persist until the animal dies. These phenomena are as follows:— the respiration is at first difficult; the inspiratory movements are more extensive and rapid; the locomotive movements less frequent, and they evidently give fatigue. Frequently, the animal remains entirely at rest: the formation of arterial blood is not prevented at first: but soon,—on the second day, for example,—the difficulty of breathing augments, and the inspiratory efforts become gradually greater. The arterial blood has now no longer the vermilion hue which is proper to it. It is darker than it ought to be. Its temperature falls. Respiration requires the exertion of all the respiratory powers. At length, the arterial blood scarcely differs from the venous, and the arteries contain but little of it; the body gradually becomes cold, and the animal dies. On opening the chest, the bronchi, in their minutest ramifications, and frequently the larger tubes, even the trachea, are found filled by a frothy fluid, which is sometimes bloody; the substance of the lung is engorged; the divisions, and even the trunk of the pulmonary artery, are greatly distended with dark, almost black, blood; and extensive effusions of serum, and even of blood, are found in the parenchyma of the lungs. Experiments have likewise shown, that, in proportion as these symptoms supervene, the animal consumes less and less oxygen, and gives off a progressively diminishing amount of carbonic acid.

From the phenomena that follow the section of these nerves on both sides, it would seem, that the first effect is exerted on the tissue of the lungs, which, being deprived of the nervous influence they receive from the brain, are no longer capable of exerting their ordinary elasticity—or muscularity—whichsoever it may be. Respiration consequently becomes difficult: the blood, owing to defective oxygenation, no longer circulates freely through the capillaries of the lungs; the consequence of this is, that transudation of its more watery portions takes place, and occasionally effusion of blood, owing to rupture of the small vessels, or to transudation through their parietes; so that ultimately all communication is prevented between the inspired air and the blood in the pulmonary vessels. The conversion of venous into arterial blood is completely prevented; the animal becomes *asphyxied*, and death is the inevitable consequence, because the mischief done to the nerves by the section, cannot be repaired. (MAGENDIE. *Précis de Physiol.* Edit. 2e. II. 355.)

The phenomena following the division of the pneumogastric nerves throw considerable light on a variety of asphyxia produced by morbid causes, to which attention was first drawn by Dr. JOHN CLARKE. (*Commentaries on some of the most important diseases of children.* 1815.) It consists essentially of a violent spasm of the constrictor muscles of the glottis, which completely prevents the entrance of air into the lungs, and destroys in the same manner as if the individual were placed in an irrespirable medium, or had a ligature put around the neck. It has been met with in the adult (KAY on *As-*

phyxia, p. 79.), but generally occurs in infants of very excitable temperament, being brought on by fits of laughter, or screaming, which call the respiratory system of nerves into immediate and irregular action, so that the glottis closes; the laugh or the scream is instantaneously arrested, and respiration at once ceases. The erethism is probably seated, in these cases, in the superior laryngeal nerves, or in the part of the encephalon whence they originate; although, as experiments on the division of the pneumogastric nerves show, paralysis of the recurrent nerves, which are distributed to the dilator muscles of the larynx, by destroying the antagonism between the dilator and constrictor muscles, may produce the same result.

1. *General phenomena of asphyxia.* These necessarily vary according as the supply of oxygen is diminished or totally withheld; and according to the degree in which the supply is diminished. There are some slight differences, also, according to the precise mode in which the supply is cut off; but still certain symptoms and appearances are met with in all.

When the access of oxygen is in any manner prevented, a few seconds elapse before any uneasiness is experienced; but after this, a marked feeling of distress indicates the necessity of satisfying one of the most imperious wants—that of respiring. This feeling soon becomes insupportable; the animal gasps, and yawns repeatedly, and makes use of every effort to obtain a supply of the indispensable fluid. The whole body is agitated. The limbs quiver; and are convulsed, or thrown into tetanic spasms. Almost instantaneously, especially if respiration has been slightly practicable, and the supervention of asphyxia therefore gradual, the feeling of distress is attended by vertigo, and stupor: the face becomes livid, especially the lips, and the orifices of the mucous membranes; and at times the whole surface assumes the same hue. The sensorial functions are suspended in a few moments; and, almost simultaneously, the muscles lose the power of contraction, so that the individual falls. In this state of apparent death, an obscure circulation alone exists in the great vessels, whilst the functions of the capillary system continue. Soon, however, the circulation ceases, first of all in the larger vessels, and afterwards in the capillaries; and, with this cessation, the functions of secretion, nutrition, and calorification, are arrested. The asphyxia has now become positive death.

Examination of the body after death exhibits general lividity of the surface, and of the face more especially. The parenchyma of the different organs is filled with fluid, especially that of the liver, spleen, kidneys, and of the lungs. Indeed, the whole general capillary system is surcharged with blood of a dark colour, which is described by some writers as always fluid (Adelon. Art. *Asphyxie*, in *Dict. de Méd.* 1 edit. p. 68.); but to this there are many exceptions. (Bérard. *Loc. Cit.* IV. 224.) The blood appears to be wholly collected in the pulmonary artery, the right side of the heart, and the venous system generally, whilst the pulmonary veins, the left cavities of the heart, and the arteries, are empty, or contain but a small quantity of fluid. The appearances, however, differ somewhat, according as the respiration is at once obstructed, or has taken place, although imperfectly, for a time. In the former case, death ensues more promptly, and there is less suffering; and, on examination, the cutaneous capillaries and the various organs are less charged with blood, and the fluid is less exclusively collected in the venous system.

The appearance of the countenance has been looked upon as a means of discrimination in death from asphyxia, where there has been much previous struggling; but it is extremely fallacious. The mechanical obstacles to the return of blood from the head, in some forms of asphyxia, and the convulsive efforts in all, give rise to protrusion of the eye-balls, and to more or less distortion of the features, whilst life exists; but these signs usually disappear, so that when death has unequivocally taken possession of the frame, no indications of suffering may be perceptible in the countenance. A recent writer (Copland. Art. *Asphyxy*, in *Dict. of Pract. Med.*) has remarked, that where no obstacle exists to the action of the inspiratory muscles,—the obstruction to respiration being in the air passages,—the efforts to renew the air in the lungs are much more convulsive and laborious; the anxiety is extreme, but of short duration, and is rapidly followed by abolition of consciousness, voluntary motion, and of the function of circulation. In this case he considers Shakspeare's description of the frightful physiognomy of Duke Humphrey, after death from suffocation, physiologically accurate:—

"But see! his face is black and full of blood;
His eye-balls farther out than when he lived,
Staring full ghastly like a strangled man:
His hair uprear'd; his nostrils stretch'd with struggling:
His hands abroad display'd, as one that grasp'd
And tugg'd for life, and was by strength subdued."

Many of these signs may, or may not exist, and this will be greatly dependent upon the length of time the mechanical violence may have been applied. If the rope, for example, were removed prior to the coagulation of blood in the vessels, they might be entirely absent; but if kept on until all circulation—general and capillary—had ceased, the congestion of blood in the vessels, and the protrusion of eye-balls, might be present as in Duke Humphrey's case. Usually, however, whatever distortion or mark of suffering may have existed prior to dissolution, there is little or no evidence of it after the spirit has passed, when the features usually exhibit a placidity of expression—a "rapture of repose"—singularly contrasting with their previously excited condition. (See Art. *Death*, and the Author's *Human Physiology*, 2d edit. II. 556.) The author has had different opportunities for examining the countenances of those who have been judicially hanged,—where the rope has consequently been removed prior to the total abolition of the vital properties,—and in none of the cases were there the evidences of suffering, in the features, that have been so often described—by poets more especially.

There is another symptom of asphyxia from mechanical obstruction to respiration, to which our attention was first directed by H. H. Hayden, Esq., a scientific and intelligent Dentist, of Baltimore; namely—redness of the teeth, which cannot be removed by maceration, so as to have the whiteness restored. This is either owing to the cause mentioned by Mr. Hayden, in the following extract from a letter with which he kindly favoured us, or to the flow of blood, in the veins of the teeth, being arrested by the cause producing the asphyxia, so that engorgement of the dental veins supervenes, with consequent transudation. The phenomenon is, in any point of view, singular:—

"In certain varieties of asphyxia, the appearances of the teeth are not only singular, but highly instructive, in a physiological point of view, especially. They are almost uniformly tinged red. If examined immediately after death, they present a deep pink hue; if some time after, the tint is darker. The different shades of colour, however, will generally depend, in a great measure, upon the age of the person, and the violence of the death:—for instance, the bony structure of the teeth of young persons is far more transparent and vascular than those of persons advanced in years. These appearances are particularly observable in the teeth of such as have been drowned, and more especially in those that have been hanged. They are, moreover, met with in the teeth of refractory bullocks that have been forcibly drawn into the slaughter-house, by means of a rope round the neck. My attention was attracted to these, and to many other appearances of the teeth, about the year 1815; since which time I have observed them in numerous instances, both in human teeth and in those of the bullock.

On examining the teeth for the purpose of ascertaining, if possible, the nature and cause of these appearances, I found, on splitting them open through the roots, or fangs (which ought to be done from the edge of the crown, so as not to touch or disturb the vessels of the tooth), the whole nervous pulp turgid, almost black, and even surrounded with blood. From this condition of the vessels, one might be led to suppose, that the red tint of the teeth was reflected through the bone. But on removing the nerves, I found that the bony substance of the tooth was literally injected with the colouring matter of the blood, and this so effectually as to render every effort to restore it to its natural whiteness, *perfectly ineffectual.*

In this condition of things, my attention was directed to an examination into the causes of these phenomena, and the following, whether correct or not, is the result at which I arrived. In order perfectly to comprehend the process, it seems necessary to premise, that the nerves, arteries, and veins, which are destined to the teeth, both of man and animals, enter them through a minute orifice or foramen at the extremity of each root, and pass into a bony canal, which enlarges until it terminates in a cavity in the crowns of the teeth. Now, in the act of drowning, I consider that the heart continues to pulsate after the lungs have ceased to play; consequently, the blood is propelled to the head, until the vessels are distended, and often ruptured, as is frequently the case with divers, who remain long under water, the blood bursting from the eyes, nose, ears, and even from the mouth. In death by hanging, or sudden strangulation, as in the case of bullocks, the truth of this position is corroborated by the following facts, which, in my mind, put the question beyond the reach of doubt. So soon as the drop falls, and the body is suspended from the gallows or otherwise, respiration of course ceases. Still the heart continues, though irregularly, its action, the very first effort of which, after the return of blood, by the compression of the jugulars, is checked, is to force the blood into the arteries of the head, and, consequently, into those of the teeth. The result is, that the arteries passing through the minute and unyielding foramina of the roots of the teeth, are so dilated, that the nerves and veins are compressed to such a degree that no blood can return by the latter. In the subsequent effort, the vessels are *completely* injected; and ultimately, not only the vessels of the teeth are injected, and ruptured, but the bony substance of the teeth, the hardest and most compact in the human body, is penetrated by at least the colouring matter of the blood.

In a letter received from my much respected friend and professional *confrère*, the late Edward Hudson, Esq., dated Philadelphia, Sept. 11, 1818, he observes—"In the small box you will find eight *very fine* teeth, if they were not red. I want your opinion of what occasions this redness, premising, that the teeth of all *drowned* persons are so, that I have examined."

In my reply, dated Sept. 26, 1818, I gave him a full explanation of the cause of those appearances, not only in the teeth of drowned persons, but also in the teeth of persons that have been hanged, and in those of bullocks drawn to the slaughter by a rope round the neck, &c., and asked him if I should return the teeth to him. In his letter and answer to me, dated Philadelphia, Jan. 31, 1819, he observes—"I take the present occasion to assure you, that you are very welcome to the teeth I was so *fortunate* as to send you. They are of use to you, and I have got some useful knowledge by a mere accident."

In 1833, I believe, two coloured persons were executed in this city—the one a male, the other a female, the latter for poisoning the wife of a medical gentleman. These subjects were examined by myself and two other medical gentlemen, after the heads had been in maceration seven weeks. The red appearance was strikingly obvious in all the teeth that were examined.

In the case of a coloured man who was executed in this city, last spring, for the murder of Capt. ——, these appearances of the teeth were equally evinced, and were, on that account, as I was informed, exhibited, by Dr. Wm. Baker, to his anatomical class."

With regard to the duration of life in cases of asphyxia, or rather to the capability of resuscitation, it is impossible to say anything definite. Where once the heart has ceased to beat, it is extremely difficult to restore it. We know nothing whatever of the cause of its action; but distension by an appropriate fluid appears to be indispensable: unless, therefore, we can succeed in propelling the blood from the lungs to the left side of the heart, so as to excite there the requisite stimulation, our efforts at resuscitation will be vain. But, although we may lay it down as a general rule, that where the action of the heart has ceased, in asphyxia, for a few minutes, we shall too often fail in saving the individual, much may depend upon a difference of resistance in individuals, referable to age, constitution, corporeal condition, &c. It is probable, too, that the more slowly the state of suspended animation has been induced, the greater will be the chance of restoration, the organs retaining longer the power of being reanimated. In some of the varieties, too, of asphyxia, lesions are apt to be produced, which inevitably destroy.

It is important to bear in mind the cases on record, in which resuscitation has been effected, as in drowning, after an immersion much longer than that we have laid down as usually sufficient to render asphyxia irretrievable; but, at the same time, we must unhesitatingly reject many of the marvellous stories that have been handed down to us on this subject, and which, strange to say, find believers even at the present day. A modern writer (Julia. *Recherches,* &c. *sur l'air marécageux.* Paris, 1823.),—after quoting Herodotus to show that a person named Scyllias could readily travel two leagues under water; and Radzivil, who affirms that he has seen some of the Egyptian fishermen remain whole days under water, without rising to the surface to breathe; and after citing, amongst other stories almost equally incredible, and yet which he seems to credit, one from Dulac, of a certain François de la Vega, who remained five years under water, and yet rose again, with life!—affirms, that no one is ignorant that the drowned have been restored to life after having remained forty-eight hours under water!—yet spite of this monstrous credulity, M. Julia's work was crowned by the *Académie Royale des Sciences* of Lyons, and received high commendations from a friendly reviewer, for the great number of interesting *facts* it contains.

Notwithstanding traditionary histories, and the philanthropic recommendation, that our attempts at resuscitation should be continued for several hours in cases of asphyxia (Curry; Wagner, in *Encyclopädisches Wörterbuch der medicinischen Wissenschaften.* Band III. s. 555.; and others), it is but too true, that our efforts will generally be fruitless, after a perfect asphyxia of a few minutes' duration.

Dr. Lefevre, of Rochefort, who was lately stationed at Navarino, had ample opportunity of putting the powers of the best divers to the test. He witnessed the performances of those who were employed to fish up the relics of the Turkish fleet sunk in Navarino harbour. The depth to which they had to plunge was 100 feet; but though the Greek divers are, and have always been, famous for their prowess, none of them could sustain submersion for two whole minutes together. Seventy-six seconds was the average period in fourteen instances accurately noted; and frequently, after reaching the surface, blood issued from the mouth, eyes, and ears of the swimmer. But in general, these people can repeat their task three or four times in an hour. (*London Med. Gaz.* 25 July, 1835. p. 608.)

2. *Theory of asphyxia.* It is all important to have correct ideas regarding the theory of asphyxia; for, according to

the views entertained on the subject, the therapeutical considerations will have to be regulated. It is a topic, too, full of interest to the physiological pathologist, and one which has elicited much discussion. Since the time of Bichat, however, the views of that distinguished individual have usually been implicitly adopted, until the experiments and reflections of Edwards, Williams, and Kay—especially of the two last—have again revived the inquiry, and led to a new and more philosophical method of viewing the subject.

Before attention was directed to the chemical phenomena of respiration, or to the changes produced on the blood in the lungs, it was generally supposed, that when respiration is suspended, the circulation ceases, owing to some mechanical obstacle existing in the lungs, or to their collapse; and this view was even maintained at a later period. (Coleman.) It was soon, however, established, that no such mechanical impediment exists to the passage of the blood through the lungs, even after the most forced expiration, and that it continues to circulate freely through them. Accordingly, Goodwyn rejected this hypothesis, and having properly appreciated the importance of the conversion of venous into arterial blood, and the necessity of a due supply of the latter for the maintenance of the circulation and of life, he supposed, that in cases of asphyxia, the blood, being no longer exposed to the influence of the air, and therefore retaining its venous character, is unable to stimulate the left auricle and ventricle to contraction; the heart, consequently, in his view, becomes, as it were, paralyzed, and dies first.

In Goodwyn's theory, no obstacle is conceived to exist to the circulation of the blood through the lungs; the cause of the asphyxia is the nonconversion of venous into arterial blood, and, as a consequence thereof, the arrival, at the left side of the heart, of blood not possessing those qualities that are requisite for exciting its cavities to contraction.

This view of the phenomena of asphyxia met with considerable favour from physiologists, and was generally adopted, until the appearance of the Researches of Bichat on Life and Death; but there were many and cogent objections to it. In the first place, if it were correct, we could not assign any satisfactory reason for the continuance, during the whole of existence, of the action of the right side of the heart, whose cavities necessarily receive only venous blood. Its presence ought to paralyze that side of the organ. Again, as was properly suggested by Bichat (*Recherches sur la vie et la mort.* p. 24.), if the dark blood paralyzed the left side of the heart, the heart's action ought to cease first, and that of the organs to follow, which is directly opposite to the fact. To overturn Goodwyn's doctrine, Bichat instituted a series of admirable experiments, which satisfactorily proved, that the heart continues to act for some minutes after respiration has ceased; that during this period, blood of a dark colour penetrates the lungs, and proves a sufficient stimulus to the left ventricle;—and he farther maintained—a point of great moment connected with his own views on the subject—that this dark blood is vigorously propelled by the heart through all the arteries, and consequently through every tissue of the body. He inserted a stopcock into the windpipe of a dog, and having exposed an artery, and divided it, he closed the stopcock, so as to completely prevent respiration. The blood, which flowed from the artery, at first issued in a full stream, and of a bright arterial hue; but as the oxygen of the air, contained in the minute bronchial ramifications, was exhausted, the blood gradually lost its arterial character, until it ultimately presented the appearance of venous blood. The stream became weaker, and smaller, and at length ceased. At the expiration of three minutes, even when great loss from hemorrhage was avoided, he found that but little blood flowed from the extremity of a divided artery,—and in five minutes there was usually not the slightest oozing; so that, he inferred, the circulation continues little more than three minutes after respiration has ceased, and the state of asphyxia terminates in the extinction of life in five minutes. From this experiment, it was clear, that, for a time, the left heart acted vigorously with nothing but venous blood in its cavities.

Led by the results of these and other experiments, Bichat propounded a theory, which, if he had made no other contribution to medical science, would have rendered his name celebrated amongst its promoters. He, equally with Goodwyn, ascribed the first link in the chain of phenomena to the nonconversion of venous into arterial blood; but he rejected the idea of Goodwyn, that any paralyzing influence is exerted upon the left side of the heart; and attributed the whole of the phenomena to the *poisonous* effects of

the venous blood on the different tissues of the body. The principal points of his theory were the following:

The venous blood, in a case of asphyxia, is sent by the contraction of the right side of the heart through the lungs, which at first contain a small quantity of air, but far too little to effect its conversion into arterial blood. On reaching the left side of the heart, the blood stimulates it to contraction, and is transmitted along the arteries to every part of the organism; but as the appropriate stimulant of these organs is blood that has undergone the vivifying influence of the air in the lungs, this unconverted, or partially converted, blood is insufficient for the purpose, and, indeed, is markedly stupifying and deleterious, so that the organs finally cease to act in consequence of being *poisoned* by the blood sent to them.

Again, the action of the nervous centres soon ceases, when venous blood is alone received by them. If venous blood be injected into the carotid artery of a dog by means of a syringe, the animal is found to present signs of suffocation, analogous to those of asphyxia, and animal life is soon entirely suspended. The same result follows the injection of blood taken from the arteries of an animal in a state of asphyxia. Bichat therefore inferred, that it is the contact of venous blood, and not any want of impulsion communicated to the brain, which causes the loss of sensation in an asphyxied individual; and this he conceived to be confirmed by the circumstance, that if the brain of an animal be exposed, and respiration be prevented by means of a stopcock attached to the trachea, the movements, impressed on the brain by the pulsation of the encephalic arteries, continue for some time after animal life, or the life of relation, has ceased. He ascribes the head-ache, vertigo, &c., which precede the loss of consciousness, to the same action of blood not *hematosed* on the brain.

When the brain has ceased to perform its functions, it would follow, that the muscles and other organs which receive their nervous supply from it, as well as from the whole of the cerebro-spinal axis, should have their functions abolished also; but to this sufficient reason, Bichat adds another—the presence of black blood in their intimate structure,—of blood which is incapable of maintaining their contraction. In proof of this, he injected blood taken from one of the veins, into the crural artery of an animal, after which its movements were sensibly enfeebled, and in some instances paralysis followed.

But not only was this deleterious influence exerted upon the voluntary muscles; a like effect was exhibited on the involuntary, or those of organic life. Their contractile power was equally annihilated, but somewhat later. Thus, the heart, after having asphyxied the other organs, by sending black blood to them, becomes itself asphyxied, owing to the black blood penetrating its own structure through the coronary arteries.

Again, venous blood does not constitute the proper pabulum for the various secretions; hence, nutrition and secretion are suspended; and, on this account perhaps, the total quantity of blood in the body appears to be greater after asphyxia than after any other kind of death.

Such are the main points of the theory of Bichat, which, as has been remarked, commanded universal assent for a long period, and which a recent writer considers "to have alone merited the suffrages of all physicians." (Devergie. Art. *Asphyxie*, in *Dict. de Méd. et de Chirurg. Prat.*) Of late years, however, it has been subjected to a fresh examination, and the labours of Williams, Kay, and Edwards—especially of the two first—have sufficiently shown, that many of the views of Bichat have been too implicitly received, and that some of them should be unhesitatingly rejected. The two points that have been chiefly attacked, are,—his assertion regarding the permeability of the vessels of the lungs in asphyxia, and that relative to the deleterious action of the venous blood on the different organs, and especially on the muscles.

Dr. Kay, whose first essays on this subject were published in a respectable British periodical (*Edinburgh Med. and Surg. Journ.* XXIX.), and who has since embodied his experiments and reflections in an *ex professo* treatise (*The physiology, pathology, and treatment, of asphyxia*), denies the correctness of the first assertion of Bichat, and maintains, that the earliest effect of the interruption of respiration is to impede and arrest the circulation of the blood in the capillary system of the lungs.

All the organs of the body, in his view, consist of a congeries of small blood-vessels, denominated, from their minuteness, 'capillaries.' These vessels are possessed of peculiar powers, by which, in a healthy state, they admit only fluids of a certain quality, excluding those that are incompatible with the functions of the part.

They even resist the forcible introduction of other fluids, when injected with a syringe. In the lungs, minute blood-vessels exist in an exquisitely delicate net-work. In these vessels, the venous blood is exposed to the influence of the atmospheric air; its qualities are changed; it loses its dark hue, and acquires a bright red colour, and hence, Dr. KAY thinks it probable, that the vessels in which the arterial blood circulates, must differ in their peculiar sensibilities, from those which propel the venous blood. The laws generally observed to regulate the action of the small vessels in other structures, would, he conceives, be violated, if the vessels which usually convey arterial blood, were able to convey, with equal facility, venous blood in every state of its changes, until it acquires its darkest colour. When air is no longer inspired, a considerable quantity of this fluid remains in the ultimate bronchial subdivisions, and so long as this air contains a certain portion of oxygen, the blood undergoes its proper change in the pulmonary vessels, and the circulation proceeds with its ordinary activity; but as the proportion of oxygen diminishes, the conversion is more and more imperfectly accomplished; the circulation becomes progressively feebler, and slower, "until, when venous blood enters those vessels which formerly conveyed arterial blood only, this degenerated fluid is no longer able to excite their action, and the circulation stagnates in the structure of the lungs. The pulmonary veins then discharge their last meagre supply through the left auricle into the left ventricle, which propels its last and feeblest tide into the arteries, in which the circulation has, every moment, become more scanty, until the pulsation has gradually been extinguished." (KAY. *Loc. Cit.* p. 21.) In this way, Dr. KAY accounts for the congestion of the venous system, and especially of the right side of the heart, and of the pulmonary artery, whilst his theory equally explains the emptiness of the pulmonary veins, and the left side of the heart.

In confirmation of his views, Dr. KAY cites an experiment of BICHAT, adduced by the latter gentleman to show, that black blood passes freely through the pulmonary vessels. He inserted a stopcock in the windpipe of a dog, and having laid bare an artery and divided it, he closed the stopcock, so as to prevent respiration. The blood flowed from the vessel, for a time, with its usual force, but at length the jet became gradually feebler. On re-

admitting the air, however, the blood became almost immediately red, and its jet visibly augmented. "In this experiment," says Dr. KAY, "the exclusion of air is not continued so long as to produce a perfect abstraction of the oxygen remaining in the air cells, when the stopcock is closed; nor to extinguish the respiratory powers, the manifestation of which is resumed as soon as the stopcock is reopened. The blood, changed in colour, but not yet so much impaired in its qualities as to be unable to traverse the lungs, still circulates, and air is admitted at a moment when the danger of the occurrence of asphyxia is imminent, but when the respiratory powers and the organic functions are still supported by a blood partially oxygenated." (KAY. p. 25.)

Again, if after a ligature has been tightly drawn around the trachea of an animal, a large artery—as the crural or the aorta—be opened, the flow of blood from the vessel soon stops, and yet the heart continues to contract energetically; the arrestation of the hemorrhage being dependent upon the left side of the heart ceasing to receive a supply of blood from the lungs.

From these and other facts, Dr. KAY concludes, that as soon as the conversion of venous into arterial blood is arrested in asphyxia, the blood gradually ceases to permeate the pulmonary vessels; and in a few minutes, the left side of the heart, no longer receiving a sufficient quantity of the fluid, ceases to contract.

It is proper to remark here, that, although Dr. KAY has but slightly alluded to the fact in his Treatise on Asphyxia, many of his conclusions had been anticipated by Dr. WILLIAMS, of Liverpool, as long ago as the year 1823. In an interesting communication published by that gentleman in the *Edinburgh Med. and Surg. Journ.*, the following positions are laid down, and most successfully illustrated:—*First.* The blood is obstructed in its passage through the lungs on suspension of respiration, whilst its circulation through the other parts of the body continues. *Secondly.* The obstruction of the blood in the lungs, on suspension of respiration, is not the effect of a mechanical cause. *Thirdly.* The obstruction of the blood in the lungs, on suspension of respiration, arises from a deprivation of pure atmospherical air. *Fourthly.* The blood which is found *post mortem* in the left auricle and ventricle, is the remnant after the last systole, and the subsequent draining of the pulmonary veins. *Fifthly.* The

obstruction of the blood in the lungs, on suspension of respiration, is one of the principal causes of the vacuity of the system circulating arterial blood *post mortem*. *Sixthly.* The immediate cause of the cessation of the action of the heart is a privation of its natural stimulus, arising from the obstruction of the blood in the lungs.

The view of Drs. WILLIAMS and KAY is entirely opposed to that of BICHAT, which it is destined, doubtless, to supplant. It is more in accordance with what we know of the physiology of the heart's action, which has ever been a deeply interesting question with the physiologist, and, in the obscurity of the subject, has given rise to various and warm controversies. By many of the ancients it was supposed to be owing to some unknown but inherent *pulsific virtue*, which enabled the organ to contract and dilate alternately, but why or wherefore was not known, or attempted to be explained. Others ascribed its action to an explosion which was fancied to take place in the ventricles; others to an imaginary archæus, whilst HALLER considered there was a *vis insita* in the muscular fibres of the heart, which was excited to action by the stimulus of the blood. It would seem as if the stimulus of distension were alone necessary, in certain cases at least, to keep up the contraction of the organ. Dr. J. K. MITCHELL being engaged in dissecting a sturgeon, its heart was taken out, and laid on the ground, and, after a time, having ceased to beat, was inflated with the breath, for the purpose of drying it. Hung up in this state, it began to move, and continued for ten hours to pulsate regularly, though more and more slowly, and, when last observed in motion, the auricles had become so dry as to rustle when they contracted and dilated. He subsequently repeated the experiment with the heart of a *Testudo serpentaria*, or *snapper*, and found it to beat well under the influence of oxygen, hydrogen, carbonic acid, and nitrogen, thrown into it in succession. Certain agents were found, however, to destroy the irritability of the organ sooner than others. Water, for example, stimulated it, perhaps more strongly, but made its substance look pale and hydropic, and in one minute destroyed action beyond recovery. (*American Journ. Med. Sciences.* VII. 44, 58.)

The second position of BICHAT, and the one on which he placed more reliance, and exhibited more ingenuity in his attempts to establish it—relative to the deleterious influence of venous blood on the different organs, and especially on the muscles—has been equally contested, and overthrown.

Many years ago, Dr. W. F. EDWARDS, of Paris (*De l'influence des agens physiques sur la vie.* Paris, 1824.), attempted to ascertain the comparative duration of life in frogs whose hearts had been cut out, and in those in which they were left untouched. By placing them in water deprived of air, the latter, in some instances, lived twenty hours longer than the former, so that the circulation of venous blood was manifestly favourable to their existence, instead of being deleterious, as BICHAT presumed.

Dr. KAY's experiments on this subject are full of interest. He properly objects to the few experiments on which BICHAT rested his opinion regarding the deleterious effects of black blood on muscular contractility,—that sufficient discrimination was not employed to discover whether the effects were caused by cutting off the supply of arterial blood, rather than from the presence of venous blood. To show that the effect is entirely owing to the ligature of the artery, he performed the following experiments.

In three rabbits, the abdomen was opened. The aorta of one was tied above the renal arteries, and also the left common iliac close to the aorta. In eight minutes, the vena cava of the second was opened; and the blood, which flowed, was injected into the aorta of the first. The contractility of both extremities was found to be equally vigorous. At the fourteenth minute, the degree of contractility having been ascertained, by the insertion of needles attached to the wires of a galvanic battery, another quantity of blood was injected. No difference whatever could be detected in the contractility of the muscles of the two extremities. The injection of venous blood, obtained from the cava of the third rabbit, was repeated twice more in the course of thirty minutes. At each interval between the injections, the wires were applied to the muscles of both extremities, when their contractility was found to decline gradually, and equally, in each, as in experiments in which the artery was simply tied. Some feeble contractile power existed for one hour. Desirous, however, of comparing the effect on the muscles, and with the blood, of the same animal, *cæteris paribus*, he instituted the following experiments, under the feeling, that if the blood of asphyxia, or black blood, have a more baneful influence on the muscular functions than the want of arterial blood, con-

tractility ought to cease sooner in the former than in the latter case.

A ligature was placed around the trachea of a rabbit, and one around the abdominal aorta, above where the superior mesenteric artery is given off. These ligatures were applied nearly at the same moment. All the muscles continued equally vigorous on the application of the galvanic stimulus. They then equally and gradually declined in excitability, and in one hour lost all evidences of it, the muscle of the upper extremity appearing towards the close of the experiment to be somewhat stronger. This experiment was repeated, and it was subsequently varied. The trachea of one rabbit was tied, and the heart of another had a ligature passed around its base. This occupied one minute. The muscles continued contractile an equal time in both. Dr. Kay consequently infers, that the supply of dark blood from the left heart has no positively noxious influence on the muscles; and that they are affected precisely in the same manner, and degree, as when the supply of blood to their tissue is prevented. He found also, that the presence of asphyxial or venous blood in the voluntary muscles supports their contractile power for a considerable period. (Kay. *Loc. Cit.* p. 154.) Farther experiments induced him to conclude, that venous blood appears to be even capable of supporting the functions of the nervous system for a short period, but a short period only. Its propulsion into the cerebral vessels soon produces languor and feebleness, but still, he conceives, the venous blood does not exert a positively noxious influence on the nervous system, nor destroy its faculties by mere contact, like a foreign fluid. In asphyxia, the imperfectly arterialized blood, which circulates through the brain, is less conducive to the maintenance of its functions than arterial blood; but those functions, and life itself, are abolished, because the circulation is arrested in the lungs when the respiratory phenomena cease. The fluid, which is then propelled into the nervous tissue, though less capable of developing its powers than arterial blood, can maintain, for a time, imperfect motions of the vital parts, and contribute to the evolution of an inferior order of phenomena. (p. 207.)

It appears manifest then, we think, that Bichat has attached too much importance to the presence of black blood in the different tissues, and that the mischief is rather to be ascribed to the absence of blood in the arteries. Were the experiments and observations of Edwards, Kay, and others, considered insufficient to establish this, the singular phenomena exhibited by malignant cholera would complete the demonstration. They are calculated, indeed, to give the *dernier coup* to the theory of Bichat, and to shake all our ideas regarding the connexion of the sensitive and locomotive functions with the circulation and hematosis. (Bérard. *Dict. de Méd.* IV. 235.) Every one who has witnessed that strange malady, must have observed the nervous and muscular actions preserved until within a few moments of dissolution, when the whole of the vascular system has been so filled with black blood, as to render the surface blue, and when arterial pulsations, even in the larger vessels, have been imperceptible. These striking phenomena have, indeed, led M. Magendie to affirm, that the contact of arterial blood is neither indispensable to cerebral action nor to muscular contraction; and a recent writer (Madden's *Infirmities of Genius*, chap. 13.) has gone so far as to assert, that the brightening up of the mind prior to dissolution, which is occasionally witnessed, but far less frequently than is imagined, is probably produced by the "stimulus" of the dark venous blood circulating through the arterial vessels of the brain; but this idea is opposed to all the received notions on the subject. (See *Death.*)

The general conclusions which Dr. Kay deduces from all his investigations, are: *First.* That the circulation is arrested after respiration ceases, because, owing to the exclusion of oxygen, and the consequent non-arterialization of the blood, the minute pulmonary vessels, which usually convey arterial blood, are incapable of transmitting venous blood, which therefore stagnates in the lungs. *Secondly.* That the arrestation of the circulation is sudden when the lungs are entirely deprived of air, and that blood ceases to flow from them into the left cavities of the heart, even in the smallest quantity, in about three minutes and a half. *Thirdly.* That even supposing a great quantity of venous blood were transmitted through the lungs, it would not impair their contractility; but, on the contrary, it is even capable of supporting this power for a certain period. That venous blood does not possess any noxious quality, by which the organic functions of these tissues can be destroyed, but is simply a less nutritious and less stimulating fluid than arterial blood; and *lastly,*—that the functions of

the muscular fibre cease in asphyxia, because the circulation, and consequently the supply of the fluid which is necessary to life, is arrested in the lungs.

Such are the chief theories that have been indulged on this interesting subject. Of these, that of Dr. Kay is decidedly the most logical, and best supported by facts. Were that of Bichat adopted, vainly might we attempt resuscitation by inflation of the lungs, seeing that every tissue, even that of the heart, has been poisoned to the total destruction of its irritability. This, indeed, has generally been regarded as a powerful objection to the view of that distinguished physiologist.

In the present state of our knowledge of asphyxia, we are justified in regarding the arrestation of pulmonary circulation in the capillaries as the first consequence of the nonconversion of venous into arterial blood; the flow of arterial blood towards the left heart is consequently arrested; and again, as a consequence of the want of the stimulus of distension, the left cavities lose their contractility; the right auricle, which continues for a time to receive blood by the venæ cavæ, being the *ultimum moriens*, not the left side of the heart, as has been asserted by some. (Copland. Art. *Asphyxy.*) The nervous, muscular, parenchymatous, and other tissues, no longer receiving a supply of arterial blood, cease also to act; but those organic functions which are effected in the capillaries of the general system—as nutrition, secretion, and calorification—yield last; circulation continuing in the capillaries for some time after it has ceased in the larger vessels.

These are probably the chief agencies concerned in the phenomena of asphyxia. One of the first effects, consequent upon the obstruction of the capillaries, and the nonconversion of the blood in the lungs, is the affection of the brain; but as Dr. Roget has properly remarked (*Cyclopædia of Pract. Med.* I. 170.), if this were the sole effect directly produced by the want of oxygen, or superabundance of carbon in the blood, asphyxia might be ranged under the head of apoplexy; and the subsequent failure of the circulation would be a consequence of the impaired energy of the nervous powers that maintain the action of the heart. But the motion of the heart, in asphyxia, is arrested much sooner than in simple apoplexy. In the latter disease, the heart continues to beat for hours, and even days, after the abolition of sensation and consciousness,—and it appears ultimately to stop, chiefly in consequence of the cessation of breathing, which always takes place when the abolition of the powers of voluntary motion has proceeded a certain length. "So that, in fact, it may more properly be said, that apoplexy proves fatal by inducing a state of asphyxia, than that asphyxia is merely a species of apoplexy, as it has been erroneously classed in some systems of nosology."

3. *General Treatment.* An attentive consideration of the different phenomena of asphyxia, presented during life as well as after death, and a comparison of these phenomena with the theory they seem so naturally to suggest, will leave but little doubt in the mind of the practitioner, as to the general resuscitative measures he ought to adopt. Still there are many particulars in which doubt might be indulged, and on which, indeed, a diversity of opinion yet exists amongst therapeutists.

The general indications will consist, *first*, in removing the individual from the causes that have produced the asphyxia; and *secondly*, in endeavouring to restore respiration, circulation, and innervation—the great vital functions, which mutually react on each other, and therefore require the simultaneous application of remedies adapted to each.

The consideration of the mode of fulfilling the first indication will necessarily fall under the examination of the particular varieties of asphyxia, as it must differ in each variety.

The chief means for fulfilling the second are,—to expose the body to that degree of heat which experience has shown to be best adapted for the support of the vital powers, and simultaneously to attempt to restore the suppressed respiration.

a. *Temperature.* For the purpose of determining the temperature, &c. best calculated for this object, the experiments of Edwards afford us some valuable aid. These experiments were instituted on different classes of animals, but the phenomena in all are of interest, as regards the present inquiry. His first topic of investigation was asphyxia as it occurs in the batrachian reptiles; and especially, whether the medium in which it may take place has any peculiar influence, independently of that which is exerted on the lungs. The most important of these media, as respects the frequency of their application, are air and water; and as the batrachian reptiles have the power of living a considerable time after the heart

has been removed from the body, the respective influence of these media can be readily appreciated. By the removal of the heart, the respiratory and circulatory functions are annihilated; the nervous and muscular systems are alone left, and these are inseparably connected. By placing, therefore, batrachian reptiles, whose hearts had been removed, in air and in water, and observing how long they continued to live in each, a comparison could be drawn of the influence of these media on the nervous and muscular systems, independently of that which they exert on circulation and respiration.

This experiment was performed on salamanders, frogs, and toads.

Two salamanders, deprived of their hearts, were placed in water of the same temperature, which had been deprived of air by boiling; and two in air: one of the former died in eight hours,—the other in nine; whilst those in air lived from 24 to 26 hours. The experiment was repeated, with similar results; whence Dr. Edwards infers, that air, in comparison with water, has a superior vivifying influence upon the system of those animals, independently of its action by means of circulation and respiration.

Similar experiments on frogs furnished analogous results. Those in water lived two hours; those in air, three. If a frog, thus deprived of its heart, and immersed in water, be taken out and exposed to the air, at the moment when all signs of life have disappeared, it immediately begins to recover. If it be again plunged in water, every appearance of life instantly ceases, and it may thus be made, several times alternately, to lose, and recover, its motion and sensibility;—circumstances which strikingly confirm the vivifying effect of air, and the deleterious influence of water, on their nervous and muscular systems.

In another experiment, Edwards strangled a number of frogs by means of a ligature passed round the neck. At first, they were paralyzed, but they afterwards recovered in a great degree, and lived from one to five days.

It would seem, from these and other experiments, that batrachian reptiles can live for many days by the aeration of the blood effected through the skin, and by the action of the air on the nerves distributed to the cutaneous envelope. That the blood is acted upon by the air, was satisfactorily shown by the quantity of carbonic acid exhaled from the surface of the body, when strangled frogs were placed in receivers containing atmospheric air,—a fact clearly showing the existence of cutaneous respiration in them.

The result of all these experiments was materially modified, however, by various circumstances, and one of the most important of these was the temperature of the medium. It was found, that as the temperature of the water of immersion was reduced, the duration of the life of frogs was prolonged, until, at 32° of Fahrenheit, or the freezing-point of water, it was more than tripled. On the other hand, elevation of the temperature occasioned a corresponding abbreviation of life, until, at 108° of Fahrenheit, or about the natural temperature of many warm-blooded animals, death was almost instantaneous.

It appeared, too, that season had a manifest influence on the duration of life;—*first*, by the temperature of the water in which the animals were immersed; and *secondly*, by the influence of the temperature of the air, for some days previous to the experiment; and when these circumstances were combined, the effect was doubled. On the 23d of November, 1817, the air and water being at 50° Fahr., and the mean temperature of the month being nearly the same, five frogs were placed in water at the same degree. They lived from 5h. 10′ to 11h. 40′; the latter period being about double the duration of life of these animals in summer, in water at the same degree. On the 22d of December, the thermometer having been about 32° Fahr. for twenty days, three frogs were put into water at 50° Fahr. They lived from 20 to 24 hours. On the 23d of December, the temperature being still 32° Fahr., four frogs were placed in water at 32° Fahr., the same apparatus being employed as in the preceding experiments. They lived from 24 to 60 hours. In the last experiment, consequently, they were placed in circumstances the most favourable for prolongation of life under water.

Experiments were made on fishes, similar to those on the batrachian animals; and first as regards the influence of temperature on their lives in water deprived of air. Comparative experiments were made on individuals of the same species, at temperatures varying from 32° Fahr. to 104°. The result was, that at the higher limit, death was as speedy as in the case of the batrachians, and the duration of life was progressively greater in proportion as the temperature was reduced towards the lower limit. It seemed, however, that the smaller and the younger

the fish, the less capable were they of bearing an elevation of temperature. At 104°, the small fish did not live more than two minutes, whilst the larger survived several minutes longer.

Dr. Edwards's next inquiry was—into the influence of the temperature of aerated water, in limited quantities, on fishes, in close vessels; and from a number of well devised and well executed experiments, he deduced the following inferences: *first*, that the duration of life goes on increasing with an increase in the quantity of aerated water, the temperature remaining the same: *secondly*, that the same result takes place when, the quantity of water remaining the same, the temperature is lowered: and *thirdly*, that the duration of life remains the same, when, within certain limits, we increase or diminish, at the same time, both the temperature and the aerated water.

The influence of the temperature on fishes was found to resemble that on the batrachian reptiles. If a bleak (*Cyprinus alburnus*) be put into a vessel with a large mouth, containing five ounces and a half of aerated water, at 68° Fahr. in summer, it dies within a few hours; but when the temperature is lowered to 50° or 53° Fahr., and is kept at that point, the animal lives until its secretions are so abundant as to corrupt the water; and if the water be renewed every twenty-four hours, it lives in it almost indefinitely.

From all his experiments on fishes, Dr. Edwards deduces, that the more the temperature is raised, beyond a certain limit, the greater is the degree of influence of the air required for their support.

Thus far, his experiments have referred only to the cold-blooded animal. Those that relate to the warm-blooded, are equally ingenious and instructive.

It has been a universal opinion, owing to the circulation of young animals being more rapid, and the function of nutrition more active, that their temperature is much higher than that of adults. The opinion is not sanctioned by observation. When new-born animals are examined, the temperature, if placed near the mother, is never found to be superior to that of the adult. But if, when the temperature is from 50° to 68° Fahr., a new-born puppy be removed and kept an hour or two from its mother, the temperature falls considerably, and continues falling, until, in the course of three or four hours, it stops at a very few degrees above that of the surrounding air. The heat begins to subside as soon as the separation takes place, and the diminution is not in the least retarded by furnishing the animal, from time to time, with milk. It would appear, consequently, from these and other experiments, that the young, of certain animals at least, produce less heat in a given time than the adult. As the animal advances in life, the difference, under the circumstances mentioned, occurs more slowly, and to a less and less extent, until, at the end of a fortnight, it can maintain itself at a temperature nearly equal to that of the parent. The new-born puppy would seem, therefore, to resemble the cold-blooded rather than the warm-blooded animal, the characteristics of the latter being acquired gradually.

The same phenomena were found to take place with kittens and rabbits, but not with the young of all the mammalia—with the young Guinea-pig, for example.

The young of the mammalia seem to be divided into two groups, in relation to animal heat; some being born, as it were, cold-blooded, others warm-blooded; and, corresponding to this difference, there appears to be another, deducible from the state of the eyes. Some are born with the eyes closed; others with them open; and until the eyes are opened they resemble the cold-blooded animal,—those that are born with the eyes open being warm-blooded from birth. "Thus," says Edwards, "the state of the eyes, though having no immediate connexion with the production of heat, may yet coincide with an internal structure influencing that function, and certainly furnishes signs which serve to indicate a remarkable change in this respect; since, at the period of the opening of their eyes, all young mammalia have nearly the same temperature as adults. (Edwards.—Hodgkin's Translation. p. 70.)

The power of producing heat seems consequently, in warm-blooded animals, to be at its minimum at birth, and it increases, according to Edwards, successively until adult age. Farther experiments appeared to show, that continued elevation of temperature diminishes the power of producing heat, whilst an opposite state of the air, provided the cold be not too severe, increases it.

The hope of producing such a change in animals, as might enable them to support the privation of air for a much longer period than is natural to them, and to become, as it were, aquatic animals, led Buffon to the discovery of a singular fact connected with young animals. He placed a greyhound bitch of the large species,

when on the point of giving birth to young, in a tub of warm water, and secured her in such a manner that she was obliged to bring them forth under water. These were afterwards, for the sake of nourishment, transferred to a smaller tub of milk, but without giving them time to breathe. They remained there for above half an hour, after which they were taken out, and all found alive. They began to breathe, which they were permitted to do for half an hour, and were then again plunged in the milk, which had, in the mean time, been warmed again. There they remained for another half hour, and when they were again taken out, two were quite strong, and seemed not to have suffered at all. The third appeared drooping, but was carried to its mother, and soon recovered. The experiment was continued on the other two: they were allowed to breathe a second time for about an hour, and were then plunged once more in the warm milk for half an hour, after which they appeared as strong as before. Being taken to the mother, however, one of them died the same day, whether from accident or the privation of air could not be ascertained. The other lived, as well as the first; and both throve equally with the other puppies, produced after the bitch was removed from the water, and which had not been experimented on.

Similar experiments were made by Le Gallois, on rabbits, which would favour the belief, that the duration of the life of new-born mammalia, under such circumstances, is about half an hour. But M. Edwards was surprised to find, that the Guinea-pig, at birth, when plunged in water, lived only three or four minutes longer than the adult,—and in other animal species the difference was not greater. On examining into the cause of this, he found, that those animals which, when asphyxied, give signs of life for half an hour, are the very species that possess feeble powers for the production of heat,—new-born dogs, cats, and rabbits, for example. It was before observed, that these animals, at this period of their existence, strongly resemble cold-blooded animals, and these facts show that they resemble them farther in the power of sustaining privation of air. On the other hand, Guinea-pigs are in the class that produce most heat at birth, and of these, Edwards says he has never seen one that lived above seven minutes under water. In them, at the end of the fifth day from birth, the duration of life in asphyxia is reduced one half; and this reduction corresponds to a sensible elevation of their temperature. The same thing is observable after another interval of five days. The heat is then much augmented, and the power of living without respiration greatly diminished; and when they have attained the fifteenth day, a period when they ordinarily possess a temperature nearly equal to that of adults, they scarcely differ from them in the duration of asphyxia. If instead of passing at once from the first to the fifth day, we examine the animal on the intervening days, we find, that during the first, and second, and not unfrequently the third, the duration of asphyxia is but slightly altered. The production of heat corresponds with this, and both phenomena likewise concur in the more marked and rapid change that takes place soon after.

The distinction pointed out between young mammalia, founded on the production of heat, is therefore applicable to them also in respect to the duration of life, when respiration is cut off. This duration has its maximum in the group of mammalia that produce the least heat at birth, and its minimum in those that produce the most.

The external temperature has likewise an influence on the duration of life in these cases. Kittens, when a day or two old, were subjected to water cooled to 32° Fahr.: they ceased to give signs of sensibility and motion after four minutes and thirty-three seconds,—taking the mean of nine experiments. At a temperature of 50° Fahr., the duration of life extended to ten minutes and twenty-three seconds, and at 68°, to thirty-eight minutes and forty-five seconds. At 86°, however, they lived but twenty-nine minutes, and at 104°, but ten minutes and twenty-seven seconds;—so that there are two great conditions, that influence the life of warm-blooded animals when deprived of air,—the quantity of heat developed by the animals themselves, and the external temperature to which they are exposed.

In the modifications of heat in man, from birth to adult age, a striking analogy is perceptible to warm-blooded animals in general. Those that are born with the eyes closed lose their heat, when they are exposed to the air in spring or summer, almost as rapidly as the cold-blooded vertebrated animals; whilst those whose eyes are open at birth, under similar circumstances, preserve a high and constant temperature. In accordance with analogy, a new-born infant, at the full period, as it has the eyes open, ought to have the power

of maintaining a pretty uniform temperature during the warm seasons; but if birth should take place at the fifth or sixth month, the case is altered; the pupil is generally covered with the *membrana pupillaris*, which places the animal in a condition similar to that of closure of the eyelids in other animals. Analogy would induce us to conclude, that in such an infant, the power of producing heat would be inconsiderable. Observation confirms this; although we obviously have not the same facilities, as in the case of animals, of exposing the young to a depressed temperature. On taking the temperature of twenty adults, it was found to vary from 96° to 99° Fahr.—the mean being 97°; whilst the temperature of ten healthy infants varied from 93° to 95° Fahr.—the mean being 94°5; and the temperature of a seven months' child, though well swathed, and near a good fire, was, within two or three hours after birth, no more than 89° 6 Fahr. Before the period at which this infant was born, the *membrana pupillaris* disappears; and it is probable, as Edwards has suggested, that if it had been born some time before the disappearance of the membrane, its power of producing heat would have been so feeble, that it would scarcely have differed from that of mammalia born with the eyes closed.

These facts are important in the present inquiry, but they are not the less so in their application to the influence of cold on mortality at different periods of life; a subject treated of elsewhere. (See *Cold.*)

A great point of information, conveyed by the experiments of Le Gallois, as well as by those of Edwards, is, that there appears to be always a certain ratio between heat and respiration in both the cold-blooded and warm-blooded animals, and in hibernating animals both in the periods of torpidity and of full vital activity. When the eighth pair of nerves is cut in the young of the mammalia, a considerable diminution is produced in the opening of the glottis, so that, in puppies recently born, or one or two days old, so little air enters the lungs, that when the experiment is made in ordinary circumstances, the animal perishes as quickly as if it was entirely deprived of air. It lives about half an hour. But if the same operation be performed upon puppies of the same age, benumbed with cold, they will live a whole day. In the first case, according to the view of Edwards, the small quantity of air is insufficient to counteract the effect of the heat; whilst in the latter it is sufficient to prolong life considerably; and he deduces the following practical inferences applicable to the adult age, and particularly to man. "A person is asphyxied by an excessive quantity of carbonic acid in the air which he breathes: the beating of the pulse is no longer sensible; the respiratory movements are not apparent; but the temperature is still elevated. How should we proceed, to recall life? Although the action of the respiratory organs is no longer visible, all communication with the air is not cut off. The air is in contact with the skin, upon which it exerts its vivifying influence: it is also in contact with the lungs, in which it is renewed by the agitation which is constantly taking place in the atmosphere, and by the heat of the body, which rarefies it. The heart continues to beat, and maintains a certain degree of circulation, although not perceptible by the pulse. The temperature of the body is too high to allow the feeble respiration to produce upon the system all the effect of which it is susceptible. The temperature must then be reduced; the patient must be withdrawn from the deleterious atmosphere, stripped of his clothes, that the air may have a more extended action upon his skin; exposed to the cold although it be winter, and cold water thrown upon his face until the respiratory movements reappear. This is precisely the treatment adopted to revive an individual in a state of asphyxia. If, instead of cold, artificial warmth were to be applied, it would be one of the most effectual means of extinguishing life. This consequence, like the former, is confirmed by experience. In sudden faintings, when the pulse is weak or imperceptible, the action of the respiratory organs diminished, and sensation and voluntary motion suspended, persons the most ignorant of medicine are aware, that means of refrigeration must be employed, such as exposure to air, ventilation, and sprinkling with cold water. The efficacy of this plan of treatment is explained on the principle before laid down. Likewise, in violent attacks of asthma, when the extent of respiration is so reduced that the patient experiences a sense of suffocation, he courts the cold, even in the most severe weather; opens the window; breathes a frosty air, and feels relieved." (Edwards, *Lib. Cit.*, and Hodgkin's Translation, p. 149.)

It is obvious from all the experiments of Edwards, that an elevated temperature of the body exhausts the nervous action, unless the animal is able, at the same

time, to have a due supply of air, and that there is a temperature, remote from the extremes of too great heat, and too great cold, which is best adapted for the recovery of those in whom respiration has been from any cause arrested. When the management of the different varieties of asphyxia fall under consideration, this subject will have to be again referred to, in its relation to each; and its bearings on the asphyxia of the new-born infant, or of one thrown into a state of suspended animation in the first few days of its existence, will be strikingly apparent. In all varieties of asphyxia, a temperature at all approaching that of the body,—and a higher than this has been recommended by the Royal Humane Society of London (*Report* for 1833. p. 100.), whose directions are the rule of conduct over every part of Great Britain at least,—must, for the reasons assigned, be positively injurious, and *à fortiori*, if such elevated temperature be applied through a medium that shuts off from the skin the vivifying influence which the contact of air is capable of exerting. In but few cases can it be safe to have the air of the apartment higher than 75° or 80°, and in some of the varieties, one of which has been specially designated by Edwards, it may be much lower than this. *Radiant* caloric, where it is demanded, is manifestly to be preferred to the *conducted*, unless its application, in the latter way, be partial, so as not to interfere greatly with the free exposure of the surface to the contact of air. The body may be placed before the fire, or in the sunshine; and warm flannels, or bags of warm grains, or of salt or sand; or bottles of warm water, or warm bricks, may be placed on small extents of the cutaneous surface. A proper temperature might be applied to the back by the tin mattresses, filled with warm water, used during the prevalence of the cholera in several of the cholera hospitals. In this partial mode of applying warmth, sufficient surface is allowed for the action of the air, as well as for the employment of friction, which, with some other agencies, and especially that of artificial respiration, are the grand means for restoring suspended animation. (Kay on *Asphyxia*. p. 40.)

b. *Insufflation.* We have said, that the application of warmth must be made simultaneously with another operation,—the most essential, indeed, of the appliances and means that have been recommended for the removal of asphyxia.

It must be recollected, that in this condition, respiration and circulation are suspended, and that innervation, which is under the dependence of these two functions, is almost annihilated. Irritability, however, still exists, whilst the blood-vessels, and the cavities of the heart, contain venous, and usually liquid, blood. Unless, indeed, this were the case, and if fibrinous concretions had formed in the cavities and in the great vessels, all attempts at resuscitation would manifestly be fruitless. In all these cases, death has supervened on the arrestation of a single vital function intimately catenated with the rest, but views have differed regarding the first seat of death: fortunately, under every view that has been entertained in modern times, the same plan of management has been inculcated. At one period, it was universally supposed, that death, in drowning, is owing to the oppression of the water swallowed; but as soon as the labours of Detharding, Plater, and others, showed that this was an error, and that death results from the privation of air, pulmonary insufflation was recommended. The theory of Goodwyn (*Connexion of life with respiration.* p. 111.), as before shown, maintained, that the contractile power of the left heart is destroyed, owing to venous blood being sent into it. Accordingly, insufflation was proposed, to change the quality of the blood in the pulmonary veins, sinus venosus and auricle, to blood capable of arousing the left heart to contraction. Goodwyn's erroneous views of the nature of the affection led him, however, to the injurious recommendation, to introduce a large quantity of air at each inflation—upwards of 100 cubic inches, for example, in the case of the adult;—a recommendation which, if universally embraced, could not fail to be followed by the unhappy consequences that are found to result from an injudicious employment of artificial respiration. Bichat, Kay, and indeed every author on the subject, whatever may be the theory he adopts,—equally recommend its employment. Under the view embraced by Kay, it is clearly the most philosophical plan of treatment that could be devised. Asphyxia, it has been seen, essentially results from the privation of air preventing the due conversion of venous into arterial blood; and, as a result of this, stagnation taking place in the pulmonary capillaries. To remove such stagnation, and re-establish the flow, this conversion must be effected; after which, arterial blood makes its way through the vessels adapted for it, but which did not allow the passage of

venous blood, and in this way, the circulation, when it has not been too long suspended, may be restored.

The most simple mode of employing artificial respiration is that proposed by Leroy, and which has since been described, at length, in the latest reports of the Royal Humane Society of London. It has a signal advantage of being available in cases where no professional individual is at hand, and can always be employed without the slightest apprehension of evil.

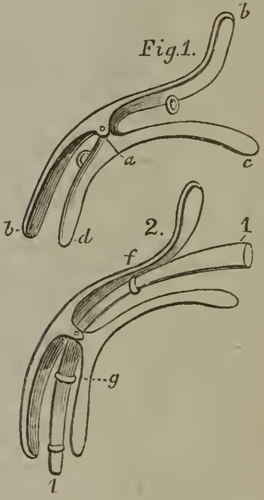
A piece of strong flannel, an old blanket, sheet, or other cloth, most easily attainable at the moment, is to be cut of the following size, and in the following manner. It should be six feet in length, and in breadth eighteen inches. Six strips are then to be cut or torn lengthwise on each side. Each strip is to be three inches broad, and two feet long. The untorn portion (two feet in length, and eighteen inches broad) is to be placed under the back of the patient, from the armpits to the upper part of the thigh bones. The strips are then to be brought together over the chest and abdomen, interlacing each other from the opposite sides, as the fingers are interlaced in clasping the hands. The strips, thus arranged, are to be gathered into a bundle on each side, and if they are then drawn in opposite directions by two assistants, the edges of the bandage will be made to approach, and firm and equal pressure will be produced on the chest and abdomen.

The assistants—having thus compressed the body of the patient by drawing the bandage in opposite directions,—should then relax it, permitting the chest to reexpand, and performing this process at the rate of about twenty times in the minute. If the head and shoulders be elevated, the contents of the abdomen, on the relaxation of the pressure, will cause the diaphragm to descend by their gravity, and will thus enlarge the chest. By applying the flame of a candle, or the fine down of a feather, to the mouth and nostrils, it will be seen, that on each firm pressure by the bandage, air is expelled from the lungs; and on the relaxation of this pressure, the chest regains its original size, and air rushes in.

Such is the plan, which may be had recourse to almost from the first moment that the body is discovered, and whilst any other means are in preparation from which more beneficial effects are anticipated: but, as soon as it can be accomplished, a more effective method of re-exciting the respiratory movements should be adopted. The pipe of a pair of bellows may be inserted into one nostril, whilst the mouth and opposite nostril are closed by an assistant, and the windpipe, in the superior prominent part, commonly called Adam's apple, is gently pressed back. Then, by forcing air into the lungs, and alternately expelling it by pressing the chest, respiration may be imitated. In this way, air may be sent into the lungs about twenty times in the minute, so as to imitate natural respiration as nearly as possible.

Another, and a more satisfactory method of insufflation, is, to pass into the larynx a bent silver canula, the larger extremity of which can be attached to the end of a flexible tube, so as to admit of a ready execution of the process. The finger must be passed towards the root of the tongue, on which it must press; in this way, the epiglottis is raised, and, by carrying the canula along the finger, it readily slides into the larynx. To facilitate this operation, Leroy has devised an instrument, represented in the annexed figure, for depressing the tongue and elevating the epiglottis.

Fig. 1.



This instrument is composed of two parts articulated at *a*, *Fig.* 1. The branch *b b* is fixed; that of *c d* movable. When the extremity *c* is elevated towards *b*, the extremity *d* is depressed, and is made to act on the base of the tongue so as to elevate the epiglottis.

Fig. 2. represents the canula 1 1 in its place. It is attached to the fixed branch

by a ring, *f*, and at the other end it follows the motions of the other branch, to which it is attached by another ring, *g*. By the movement of this branch, and the corresponding depression of the base of the tongue, and elevation of the epiglottis, the canula is directed to the opening of the larynx, into which it can be readily made to enter.

Such an instrument, however, can be rarely necessary, and it will probably be no more used than the various modifications of the bellows, that have been recommended by Gorcy, Ruland, Kopp, Configliacchi, and others.

Where none of the apparatus we have described is at hand,—but this can rarely happen, for in almost all situations, a bandage, of the kind recommended for establishing artificial respiration, can be met with,—it has been advised, that air should be forcibly blown into the lungs, by applying the mouth of the operator to that of the patient, closing his nostrils with one hand, and gently expelling the air again, by pressing the chest with the other, or by the aid of an assistant; and if any difficulty be experienced in this method, air may be blown in at one nostril, keeping the other closed, and pressing the larynx back upon the œsophagus, in the mode already described, so as to prevent the introduced air from passing down into the stomach: or one of the curved canulas may be introduced, and air sent through it. But this method has not met with the approbation of every observer, and for obvious reasons. When the air issues from the lungs of an individual, it has experienced such a change in its composition as to be no longer adapted for continued respiration. It is true, that it loses not more than three parts of its oxygen, which are replaced by carbonic acid gas. Still, it has ceased to be the appropriate fluid—atmospheric air—for the maintenance of the respiratory function, as experiments on animals sufficiently demonstrate. On the other hand, the introduced air has its temperature elevated, so that the advantage of the higher temperature, it has been conceived, may nearly counterbalance the disadvantage of less purity (Copland. Art. *Asphyxy*, p. 133.); but this we have seen may be advantageous or disadvantageous according to the case. It is more than doubtful, indeed, whether in any case of asphyxia, in the adult, the application of a temperature of upwards of 90° to the body can be useful. Bérard considers that the danger or dread is slightly exaggerated, as the air is so little changed, and moreover, in spite of every precaution, where a tube is not used, the air must pass, more or less, into the pharynx and even into the œsophagus, so that it cannot enter in quantity into the lungs. (Art. *Asphyxie*, in *Dict. de Méd.* IV. 240.)

The advantages, however, attending the insufflation of the pure air of the atmosphere, are so overwhelming, that it ought always to be adopted, when practicable. There is, indeed, one variety of asphyxia where such deteriorated air can hardly be looked upon as objectionable;—the asphyxia of the new-born child, or of one that has respired but for a short period. The presence of a full portion of oxygen is not here so indispensable as it is afterwards; but this variety will have to be considered hereafter.

At one period, pulmonary insufflation was universally practised, and without the slightest cautions. It was even recommended, as has been just observed, that the air should be *forced* into the lungs so as to penetrate the minute air cells; and it is somewhat surprising, that after the anxious consideration which had been previously given to the subject, and which was even at the time given to it by physiologists, Dr. Roget (*Cyclopædia of Pract. Med.*) should have inculcated the same forcible measures, without any qualification whatever. "The object," he remarks, "being to introduce pure air into the inmost recesses of the air cells, so as to exert a chemical action upon the blood in the pulmonary vessels, some degree of force must be used in order to overcome the mechanical obstacles to its admission. For this purpose, a considerable quantity of air should be introduced at each inflation; for, as Dr. Goodwyn observes, if only twelve cubic inches be injected at a time, this small quantity will occupy the larger branches of the trachea, and consequently only a small number of the pulmonary vessels will be exposed to its action: but if a much greater quantity of air be forced in at each time, some of it will pass into all the more remote cells; and when they are thus uniformly distended, the pulmonary veins, the sinus venosus, and left auricle, will be exposed as much as possible to its action, and some of the arterialized blood may be forced into them from the capillary vessels."

Of late, however, it has been shown, that the apparently simple operation of inflating the lungs is not as devoid of danger as was for a long time imagined; and it has been attempted to prove, that many cases may have resulted fatally from the

violence of the insufflation, and consequent lesion of the pulmonary structure. (Kay on *Asphyxia*, p. 43 and p. 226; and Magendie, in *Journal de Physiologie*, IX. 105.) Some of the statistical evidences on which this opinion is founded will be given under the section on *Asphyxia from submersion.*

Bichat had remarked, that where air is forced violently into the lungs of an animal, infiltration of air may be produced owing to rupture of some of the pulmonary vesicles, and, within the last few years, M. Leroy d'Etioles has instituted a series of experiments, which have confirmed the observations of Bichat. (*Journal de Physiologie*, VII. and VIII.; and *Rapport sur un Mémoire de* M. Leroy d'Etioles, *relatif à l'insufflation du poumon*, &c., par MM. Magendie et Duméril, in *Revue Médicale*, XIII.) He found, that if air was blown into the lungs, and with no greater strength than that of an expiration from the human lungs, it proved fatal to rabbits, foxes, goats, sheep, and other animals. The experiment was performed by briskly inflating the lungs from the mouth of the operator. All animals were not, however, equally affected by the operation. The tissue of the lungs of the dog, for example, is denser than in the animals mentioned, and therefore resists the insufflation better; and the same remark applies to the lungs of infants, which were not lacerated, even when the inflation was practised with considerable force,—a fact which was confirmed by the experiments of MM. Magendie and Duméril. Similar experiments, made on the dead bodies of adults, exhibited that a like rupture of the air cells could be effected by simple oral insufflation.

Where the pulmonary vesicles are ruptured in this manner, the air passes into the cavity of the pleura, and presses upon the lungs, so that they cannot be inflated, unless the effused air be removed by a puncture made in the chest, and then reinflating the lungs by the trachea. A *post mortem* examination of many of the cases, that proved fatal after insufflation, sufficiently exhibited their true pathology; the diaphragm being found pressed into the abdomen, so as to form a prominent elastic tumour in that cavity, and the lung contracted into a small space in the chest.

In the experiments on animals, relief was afforded by making a puncture through the parietes of the chest, immediately after brisk insufflation had been practised, and thus permitting the effused air to issue from the cavity of the pleura. The animals, treated in this manner, recovered, although they exhibited much embarrassment in breathing for some hours.

To remedy these inconveniences, Leroy has recommended a modification of the resuscitative apparatus. He employs the double-valved bellows of Hunter, to the handles of which he has adapted the graduated arc of a circle. One end of this arc is attached to one handle of the bellows, whilst the other passes through a mortice-hole in the other handle. The extent to which the handles are separated is measured by the graduated arc, and thus the quantity of air sent into the lungs may be determined. With his bellows, he measured the quantity of air expired, without effort, into a bladder, by persons of different ages, and marked upon the arc of the circle the point to which the handle of the bellows was raised in each. He moreover had the curved tubes, to be introduced into the glottis, made of a different calibre, according to the age, so as to render it impossible to introduce the proper quantity of air, as indicated on the arc of the bellows, more rapidly than it would be inspired at that age.

The apparatus is simple, and its adoption has been properly and strongly advised, on the ground, that verbal directions often fail to impress the mind with a due sense of the dangers attending insufflation, especially when it must be performed in such excitement, and confusion, as cannot fail occasionally to diminish the caution even of experienced persons. (Kay on *Asphyxia*, p. 230.) In most of the cases of asphyxia, however, that occur, no such apparatus can be at hand, and the operator is consequently constrained to make use of the agents which present themselves. These should of course be employed with the greatest precaution, to prevent the evils that have been depicted by Leroy.

In adopting any form of insufflation it is important to imitate, as far as possible, the natural movements of inspiration and expiration; not to go on incessantly forcing air into the lungs, but, by means of the pressure before mentioned, to force the air from the chest before a fresh quantity is sent in. This is one of the strong objections that may be urged against the plan, which has been recommended, where difficulty is experienced in introducing a curved tube into the glottis,—of making an incision into the windpipe, and inserting the nozle of the bellows into it, so as to maintain artificial respiration. In order that expiration shall be accomplished, the nozle must necessarily be alternately

withdrawn and inserted, so that great violence must be done to the parts. A fatal case of this kind is given by Mr. Franks. (*Observations on animal life and apparent death.* London, 1790. 8vo.)

Lastly, it has been recommended to substitute oxygen gas for atmospheric air, and that the resuscitative apparatus should contain a quantity in a well-stopped bottle (Wagner. Art. *Asphyxie*, in *Encyclop. Wörterb.*); but although it might seem probable, that the substitution of oxygen would be advantageous, so few cases of its employment are on record, that Mr. Armiger, when about to prepare a work on suspended animation—which has not yet seen the light—solicited from the profession accounts of cases successfully or unsuccessfully treated, but his call was not responded to. (*Lond. Medical Repository*, Jan. 1822.) Goodwyn employed this gas in several instances in asphyxia of the smaller animals, and he thought, that recovery was commonly more expeditious than where atmospheric air was used; but at the same time he admits, that he had never been able to resuscitate an animal by oxygen gas, after atmospheric air had been vainly employed.

We can readily appreciate the principle on which inflation with oxygen gas should be recommended; but it is not so easy to comprehend that on which Ackermann should advise a mixture of 80 parts of atmospheric air, and 20 of chlorine (*Schrift. über den Scheintod* u. s. w.), unless it were upon the same principle that Hunter (*Observations on the animal economy*, p. 136.) advised the inhalation of stimulating vapours. The recommendation appears, however, to have fallen stillborn from its originator.

c. *Excitants.* Agents of this kind were sure to have early suggested themselves. The vital powers being suspended, or, as it was conceived, in a state of torpor, excitants would naturally seem to be demanded in every case of asphyxia. *Friction* has been advised by all, although, Dr. Roget remarks, its importance, even as an auxiliary means of restoring life, may have been much overrated. (Art. *Asphyxia*, in *Cyclop. Pract. Med.*) It can, of course, be of no use where the circulation has entirely ceased in the capillary vessels; but in such a case all applications would probably be equally unsuccessful: when, however, even an obscure circulation goes on in them,—and we have seen that this may be the case for some time after the action of the heart has ceased,—the remedy is certainly philosophical, if used with the more important means already considered.

The effect of frictions, like that of local excitants in general, is to produce rubefaction, or, in other words, to solicit the blood into the extreme vessels, so that an impulse is thus communicated to the greater and more important parts of the vascular system; whilst the excitation of the subcutaneous nerves is communicated to the brain, and thence to every part of the organism. In such cases, therefore, as admit of any hope of relief, the employment of friction may be strongly inculcated. It may be applied with the naked warm hand, previously dipped in flour, to prevent abrasion; or by the flesh-brush. The part of the body that may be selected with this object is not material, but generally the extremities are recommended.

Various other excitants have been advised, such as tickling the nostrils or the fauces with a feather; applying spirits of hartshorn or aromatic vinegar to the Schneiderian membrane by the same instrument; burning sulphur under the nose of the patient, as well as other volatile irritants; but they can be of little or no use until the sensibility is restored by other means,—and then they are probably unnecessary.

With similar views, brandy and water, or hartshorn and water, or negus, have been thrown into the stomach by means of the stomach tube; and irritating turpentine or spirituous enemata, or salt, or vinegar, or chlorate of potassa in solution, have been administered in the same form. Their use can only be productive of benefit under like circumstances, and they had better be cautiously employed in all.

The effect of electricity, in the different forms in which it is adopted in medicine, on the functions of sensibility, and muscular contraction, could not fail to suggest it early to observers as a means for restoring suspended animation. It is doubtless a most valuable agent, but is rarely available, for reasons that are obvious. J. P. Frank, Thillaye (*Archives Gén. de Méd.* XII.), and others, have strongly recommended it; the latter gentleman on the strength of numerous experiments on animals. As the object, in these cases, is to arouse the respiratory muscles to action, the electric shock may be passed through the shoulders, or through the chest in any direction. Neither common nor galvanic electricity is possessed of any power in restoring the action of the involuntary muscles. We have fre-

quently attempted to re-excite the action of the heart, intestines, fibres of the uterus, &c., soon after the cessation of respiration and circulation, by means of the galvanic stimulus, but without the slightest success, although the voluntary muscles responded to it most energetically. Beside, were the action of the heart to be re-excited by it, this could be but momentary. An appropriate stimulating agency is distension, and unless the respiratory movements were restored, and conversion of venous into arterial blood effected, so that the latter could reach the left heart, the action of that organ could not be maintained. Every attempt, therefore, is properly made to restore the action of the respiratory muscles, so that hæmatosis may be accomplished.

It has been advised, that the great nerves should be exposed in the neck; and that whilst the wire, connected with one pole of the galvanic battery, is applied to the pneumogastric nerve, for example, the other wire should be placed on the epigastrium. It is probable, however, that every effect would be produced by a simple incision through the integuments of the neck, into which the wire might be passed.

M. Leroy d'Etioles has suggested a new method of application, which, at the first aspect, appears to be most formidable, but is really less so than it seems, in consequence of the impunity with which fine needles can be made to penetrate even the most important organs. (See Art. *Acupuncture.*) He introduced an acupuncture needle on each side, between the eighth and ninth rib, until they reached the fibres of the diaphragm. He then established a galvanic current between these, by means of a pile of 25 or 30 pairs of plates, an inch in diameter. The diaphragm immediately contracted, and an inspiration was made. He then interrupted the circle, when the diaphragm, urged by the weight of the abdominal viscera, and aided by gentle pressure made on the abdomen by the hand, returned to its former position, and an expiration was accomplished. In this way, the two respiratory acts were made to succeed each other, and regular respiration was re-induced. A continuous current was likewise applied in some cases, but the respiratory movements were irregular, and nothing like natural respiration resulted.

Leroy tried his method on animals asphyxied by submersion, and when they had not been under water more than five minutes, they were often resuscitated. The experiments were witnessed by Magendie. (*Journ. de Physiol.* IX.) On different occasions, M. Leroy asphyxied animals of the same species, and apparently of like strength, and whilst those that were left to themselves perished, those that were treated by galvanism recovered.

As an aid, therefore, to pulmonary insufflation, and an important one, galvanism might be advantageously employed in asphyxia; but, as has been already remarked, it can rarely be available. Certainly no time should be lost in adopting the other energetic and indispensable measures that have been already advised. It has been recommended, that as only a very small apparatus is necessary, batteries, consisting of a few plates, might be kept wherever there are station-houses for the reception of persons in a state of asphyxia. (Kay on *Asphyxia*, p. 232.) The suggestion is good; and they might with propriety also form a part of the cabinet of apparatus of the private practitioner; but whilst an assistant is preparing it for action, the practitioner should be energetically engaged in applying his other means of resuscitation.

d. *Bleeding.* This operation requires much caution, when practised to anything like the extent of an ordinary bleeding; but there are perhaps few cases of asphyxia, in which blood can be abstracted, where the loss of a few ounces would not be beneficial, along with the other resuscitative measures. The venous system is always surcharged with blood, and the removal of this quantity could scarcely fail to aid in the re-establishment of the circulation, without the danger of its extinguishing vitality, that has been apprehended. It is a measure, however, regarding the propriety of which, much difference of opinion has existed. Mr. Hunter strongly reprobated it, and the Royal Humane Society of London recommend the "utmost caution" in its employment. On the other hand, Wagner (Art. *Asphyxie*, in *Encycl. Wörterb.*) regards the removal of the oppression of the encephalon, owing to the accumulation of blood in its vessels, as the *second* indication to be fulfilled in many kinds of asphyxia, the *first* being the restoration of the circulatory and respiratory movements. It has already been remarked, that the abstraction of some ounces of blood must usually be beneficial in aiding the restoration of the circulation; but the grand evil, after all, is the deficiency of fluid sent by the arteries, which bleeding can only rectify indirectly, by aiding in the re-establish-

ment of the circulation. A recent writer affirms, that when the individual has only just lost all consciousness, a "large bleeding" may produce the most satisfactory results, and that if it cannot always be employed at the first, it often facilitates the restoration of the circulation, when attempts at respiration are made. (Devergie, *Loc. Cit.* p. 550.) The general reprobation of blood-letting in asphyxia seems scarcely warranted; and indeed, as we have already said, there are perhaps few cases, in which a moderate abstraction of blood would not be beneficial.

Such are the chief remedial agents employed in asphyxia. We have said nothing of stomach-brushes, and stomach-mops, for stimulating that organ; of the internal use of phosphorus, as suggested by Dr. Good (*Study of Medicine*); of the instillation of hot water on the head, scrobiculus cordis, genitals, spine, &c.; the dropping of hot sealing-wax on the head; sticking needles under the nails; the application of the actual cautery, &c.—because these are forms of excitants, from which but little good could, in any case, be expected, whilst there are others that are more appropriate in all.

With regard to the length of time that the resuscitative measures should be continued, it is difficult to lay down any precise rule. We shall find, when the particular forms of asphyxia are considered, that, in some, restoration appears to have been effected after a greater lapse of time than in others, so as to have given rise to the idea, that the impression, made on the nervous system by the cause producing the asphyxia, may have occasioned syncope rather than true asphyxia. Under the possibility, that restoration may still be accomplished in very unpromising cases, it has been advised, that the means should be persevered in for several hours, and indeed, until cadaveric rigidity begins to appear.

A good deal must necessarily depend upon the length of time the individual has been exposed to the agency that has occasioned the asphyxia; and the practitioner in every case will have to be guided by his own judgment as to the probability of success from the application of any restorative measures; bearing in mind the cases on record of recovery after a long suspension of the vital manifestations, but, at the same time, recollecting, that such fortunate examples are extremely rare. Occasion, however, will present itself for a recurrence to this subject.

When the resuscitative measures are beginning to be successful, slight convulsive snatchings of the respiratory muscles will take place at longer or shorter intervals; with gaspings, sighing, slight fluttering at the heart, palpitations; and afterwards regular respiration, and circulation. The patient, however, should not be abandoned by the practitioner immediately after resuscitation has occurred, as, in consequence of the condition in which the encephalon has been placed, during the existence of asphyxia, and the irregular movements occurring during recovery, delirium or convulsions may supervene. A case is given in a respectable French periodical (*Archives Gén. de Méd.* Juin, 1829.), in which the most furious delirium came on immediately after resuscitation from drowning, and where blood-letting appeared to be clearly indicated. This will have to be judged of by the presence of the usual signs, that denote increased action of the encephalic vessels.

Dr. Paris, too (*Life of* Sir Humphry Davy, 4to. edit. p. 69.), gives the case of a corporal of the guards, who was seized with cramp as he was bathing, and remained for several minutes under water. By judicious assistance he recovered, and appeared to those about him to be free from danger, when he was attacked with convulsions and expired. Dr. Roget suggests, that if the respiration had been artificially supported at this period, so as to have maintained the action of the heart, until the black blood had returned from the brain, it is probable, that the life of the soldier might have been preserved (*Cyclop. of Pract. Med.* I. 181.); but it is more probable, that some lesion had taken place in the encephalon, consequent on the modified circulation in that viscus, rather than on the presence of black blood in the vessels, which must have been sent back towards the heart from the first re-establishment of the circulation,—and this view is confirmed by the fact, that convulsions sometimes occur a considerable time after recovery has, to all appearance, been effected.

Various inflammatory symptoms are apt to supervene, owing to the same irregularity,—which must be met as they arise, until the functions are restored to the healthy condition.

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§ 2. *Of the varieties of Asphyxia.* The remarks made, in the history of asphyxia in general, will render it unnecessary to dwell, at any great length, upon the different varieties. Respecting the number of these, the greatest discrepancy has existed, in consequence of the difference of latitude given to the acceptation of the term. The causes, previously referred to, will guide us in establishing a few varieties:—*first,* those that arise from any mechanical obstacle to the due expansion of the chest;—*secondly,* such as are dependent upon an insufficient supply, or upon total absence, of oxygen in the inspired air;—*thirdly,* those that are produced by irrespirable gases;—and *fourthly,* such as are owing to any mechanical cause, which prevents the entrance of air into the lungs.

1. The brief allusion, that has been made to the first of these, will be sufficient. It can rarely happen, that asphyxia is induced by any extrinsic cause, that can prevent the due expansion of the chest in inspiration, and therefore, as a question of therapeutics or of legal medicine, it is possessed of but little interest, whilst its pathology does not differ from that of asphyxia in general. As, however, death takes place in consequence of imperfect

hematosis, and supervenes gradually instead of suddenly, as in many of the other forms of asphyxia, the evidences on dissection may be more equivocal; there may not be the same extent of fulness in the right heart, or of vacuity in the left; nor ought we to expect those extravasations into the lungs or encephalon, which are so common whenever the circulation from the right side of the heart to the left has been suddenly arrested.

Allusion has been already made to the cases in which this variety of asphyxia has presented itself,—namely, as a punishment in Turkey, and as a means of judicial compulsion, where a witness has persisted in remaining wilfully mute. Occasionally, too, it has happened, that this mode of taking away life has been adopted criminally with the infirm, as in some of those infamous examples of turpitude, which excited so much horror and alarm, in the British metropolis, a few years ago. In these cases of refinement of cruelty, after the victim had been 'hocussed'—as it was termed in the slang vocabulary—by stupefying him with opium in some form, the hand was pressed upon the mouth so as to prevent the entrance of air, whilst the expansion of the chest was prevented by sitting upon the body. In this way, death was as speedy as if a ligature had been passed around the neck, or the individual had been thrown into an irrespirable medium.

2. Of the variety of asphyxia, which is dependent upon an insufficient supply or total absence of oxygen in the inspired air, we have many examples.

It has been before remarked, that extremely rarefied air, and various gases, which are not of themselves positively deleterious, may become negatively so;—or, in other words, they may destroy, not in consequence of their being possessed of any noxious property, but because they do not furnish the oxygen, which is indispensable to hematosis. Hydrogen and azote are in this category. If an animal be placed in either of these gases, it breathes for a minute perhaps; but the conversion from venous to arterial blood in the lungs being prevented, arrest of the circulation, in the radicles of the pulmonary veins, occurs, in the same manner as in other cases of complete asphyxia. We can hardly, however, imagine the case, in which asphyxia from exposure to these gases could happen to man. The same may be said of an extremely rarefied atmosphere. For the purposes of experiment we occasionally place one of the lower animals under the receiver of the air-pump, and rapidly exhaust the air: the effect is here speedy, if the vacuum be suddenly formed, and the pathology of asphyxia, thus induced, is like the forms which we have just considered; but if the rarefaction be made more gradually, asphyxia is longer in being produced, and the phenomena are much more equivocal.

In the respiration of animals, the oxygenous portion of the air is more or less consumed, and carbonic acid, of a nearly equal volume, takes its place. In other words, the vital portion of the air is abstracted, and an equal volume of air, which is altogether irrespirable, is added to the azote—which, as we have seen, is itself negatively injurious. Now, if an animal be confined in a restricted quantity of atmospheric air, it can exist so long as there is oxygen enough for due hematosis, and so long as the deadly agencies of the carbonic acid and the azote are not powerful enough to destroy. The bad effects of confined air might, therefore, be mainly, if not wholly, ascribed to the presence of an undue quantity of carbonic acid, and to the uncombined azote, left after the disappearance of the oxygen. This, at least, is one view of the matter; but those physiologists, who believe that the air is taken into the pulmonary vessels without decomposition; that its oxygen disappears in the course of the circulation, and that carbonic acid is formed in the system, and merely given off at the lungs,—a view which appears to be the most in accordance with observed facts,—would ascribe the phenomena to the deleterious agency of the carbonic acid.

Instances have occasionally occurred, where death has been caused in this way,—as in a diving-bell, where the air could not be renewed; but the most melancholy example on record was in the—since celebrated—'Black Hole' at Calcutta—a place of confinement 18 feet by 18, or containing 324 square feet, in which one hundred and forty-six persons were shut up, when Fort William was taken, in 1756, by Surajah Dowla, Nabob of Bengal. The room allowed to each person a space of 26½ inches by 12 inches, which was just sufficient to hold them without pressing violently on each other. To this dungeon there was but one small grated window, and the weather being very sultry, the air within could neither circulate nor be changed. In less than an hour, many of the prisoners were attacked with extreme difficulty of breathing; several were delirious, and the place was filled with in-

coherent ravings, in which the cry for water was predominant. This was handed to them by the sentinels, but without the effect of allaying their thirst. In less than four hours, many were suffocated, or died in violent delirium. In an hour more, the survivors, except those at the grate, were frantic and outrageous. At length, most of them became insensible; and, eleven hours from the time they were imprisoned, of the one hundred and forty-six that entered, twenty-three only came out alive, and these were in a highly putrid fever,—from which, however, by fresh air, and proper attention, they gradually recovered. A similar instance happened in London, in 1742. Twenty persons were forced into a part of Saint Martin's round-house, called 'the Hole,' during the night, and several died.

In these, and in all similar cases, the lethiferous influence is doubtless of a compound character; being dependent both upon diminution of oxygen, the presence of uncombined azote, and of an unusual quantity of carbonic acid. This acid, which, as we have seen, is given off in respiration, is heavier than atmospheric air, and consequently accumulates near the ground, where ventilation is impracticable or neglected, and it can thus be readily understood, that where the only aperture into the chamber is by the roof, or by a window high above the ground, the lower strata of air may become irrespirable for some time before the upper.

3. The gases which produce death by occasioning a spasmodic closure of the glottis, or which are *irrespirable*, are not many. They are the carbonic acid, ammoniacal gas, muriatic acid gas, deutoxide of azote, nitrous acid gas, and chlorine. We have before observed, that different writers have classed under this head, oxygen, the protoxide of azote, carburetted hydrogen, carbonic oxide, sulphuretted hydrogen, and arsenuretted hydrogen; but these gases give rise to no symptoms resembling asphyxia. They are positively deleterious, and act upon the frame as *poisons*, under which head they will be considered.

A similar remark might, indeed, be extended to the gases enumerated as producing asphyxia by spasmodic closure of the glottis, when their strength is reduced below a certain point. Above this, contraction of the muscles that close the glottis is produced, as soon as the gas comes in contact with them; but if sufficiently diluted, they may pass into the lungs, and exert upon those organs, and through them on the organism, the peculiar effects which they are capable of inducing. Thus, carbonic acid may cause symptoms of narcotism, whilst the ammoniacal gas, the muriatic acid, the deutoxide of azote, the nitrous acid gas, and chlorine, may produce violent irritation, and inflammation of the air passages. It is, however, in their relations to asphyxia that we have to consider them at present.

Carbonic acid gas is by no means an uncommon cause of asphyxia, and it has not unfrequently proved fatal more slowly by the poisonous *narcosis* which it induces. Sir Humphry Davy found, that air was still irrespirable, when it contained three-fifths of its volume of carbonic acid.

This gas accumulates wherever combustion is going on; but it is the accumulation from brasiers of charcoal, where ventilation is impeded, that has been most lethiferous. The Journals contain accounts of many persons who have perished during the night, from this cause; and it was the method adopted by the younger Berthollet to rid himself of a disagreeable existence, in which he succeeded. In crowded apartments, artificially heated and well lighted, inconvenience,—such as hurried respiration and circulation, giddiness, &c.—are not unfrequently experienced from the presence of this gas, and allusion has already been made to its being concerned in the fatal affair of the Black Hole. It is the fixed air given off during the vinous fermentation; and, in the large vats of extensive ale and porter breweries, sufficient of the gas is often contained at the bottom to destroy those who may venture down. It is usual to pass a lighted candle to the bottom, and if it continues to burn, the descent may be made with safety,—carbonic acid not supporting combustion. In like manner, it is met with in deep wells, and the same plan is adopted to discover whether the air will allow of combustion and respiration; but many a labourer has fallen a victim to his want of attention to this precautionary measure. This air likewise constitutes the *choke-damp* of the coal mines, in contradistinction to the *fire-damp*, which consists of carburetted hydrogen. It issues in some volcanic regions in great quantities, from fissures in the rocks, and is found in caverns, as at Pyrmont in Westphalia, and at the celebrated Grotto del Cane at Naples, so called in consequence of the number of dogs that are asphyxied in this collection of irrespirable gas. Carbonic acid is also extri-

cated in considerable quantity in lime-kilns, by the agency of heat, which drives it off from the limestone or carbonate of lime,—and the public prints have detailed many cases in which life has been lost, owing to the poor benighted traveller having laid himself down to rest in the warm but destructive atmosphere around one of these furnaces.

Lastly.—Plants evolve carbonic acid in the night, which renders the air of confined apartments unwholesome, and, in some cases, induces asphyxia. An instance of this kind is cited from the public prints by Dr. PARIS. (PARIS and FONBLANQUE. *Med. Jurisprudence*, II. 49.) A gentleman, having frequently had his pinery robbed, the gardener determined to sit up and watch. He accordingly posted himself with a loaded fowling-piece in the green-house, where, it is presumed, he fell asleep, and in the morning was found dead upon the ground, with every appearance of suffocation, supposed to have been occasioned by the disengagement of 'mephitic gas' from the plants during the night.

Carbonic acid cannot be breathed in a pure state, or even, as we have seen, when diluted with two-fifths of its bulk of atmospheric air. It occasions an immediate spasmodic closure of the glottis, which cannot be overcome by the strongest efforts, preceded by painful irritation of the glottis and the upper parts of the throat. When, therefore, a person descends into a brewer's vat, a foul well, &c., in which the gas is in a concentrated state, he dies as speedily from suffocation, as when a ligature is put round the neck so as to completely shut off the entrance of air into the lungs.

With regard to the discrimination of asphyxia produced by the inhalation of carbonic acid, nothing can guide us except the history of the event, which may be deduced from the circumstances surrounding the individual,—not from any intrinsic evidences. Pathological anatomy, independently of circumstantial evidence, does not indicate any phenomena, which distinctly show, that death has resulted from this variety of asphyxia rather than from any other.

In the *treatment* of asphyxia from the respiration of carbonic acid, the first important procedure is to withdraw the patient from the deleterious atmosphere, and strip him of his clothes, in order that the air may come freely in contact with his skin. He must then be exposed to cool air, and cold water be thrown upon his face, until the respiratory movements reappear. The reasons for this plan of management have been given previously. Friction over the chest must also be employed, and ammonia may be held to the nostrils, so as to stimulate the oppressed energies. These are the most important steps; but, in addition, insufflation has been advised to remove the noxious gas from the lungs, and to re-excite respiration; and Galvano-puncture, in the mode recommended by LEROY d'Etioles, for stimulating the diaphragm to contraction. It has been conceived, too, that the insufflation of oxygen might be serviceable; and, by some, blood-letting has been employed; but it is not easy to discover the rationale of the action of these agents. The judgment of the practitioner must suggest to him, whether these or other means, adapted to particular emergencies, may be indicated.

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NICOLAS, (P. F.) *Dissertatio de variis vaporibus mephiticis, et novo quo suffocati ad vitam revocentur auxilio.* Nancy, 1781. 4to.

The *ammoniacal gas*, as well as the *muriatic acid gas*, the *deutoxide of azote*, *nitrous acid gas*, and *chlorine*—when in a state of concentration—are so acrid, that, when inhaled, the most violent irritation of the air passages is induced. It has generally been conceived, that they prove fatal by occasioning spasmodic closure of the glottis, but, from some experiments made by Mr. BROUGHTON (*Journal of the Royal Institution*, Vol. I. for 1830.), it would seem, that certain of them pass the rima glottidis in sufficient quantity to produce phenomena, which are apparent on dissection. In some experiments, which he made on the effects of chlorine on several mice, he found, that they fell dead in less than thirty seconds, and, on opening them, the lungs were found tinged with the yellow colour of the gas, and the peculiar odour of chlorine was perceptible throughout their structure.

Still, it is probable, that death arises from asphyxia, not from the poisonous influence of the gas, the effects of which could scarcely be exhibited in so short a space as thirty seconds.

The smell of these agents will enable us to judge—in the absence of any history of the case—as to the cause of the asphyxia.

The *treatment* is similar to that for asphyxia by carbonic acid gas; and, in ad-

dition, insufflation with sulphuretted hydrogen gas—largely diluted with common air—may be advantageously had recourse to.

As these gases are extremely irritating, there may be a greater necessity for the employment of blood-letting, in asphyxia induced by them.

4. But the most interesting varieties of asphyxia are those that are owing to some mechanical cause preventing the entrance of air into the lungs. Some of these we shall consider in detail.

a. *Asphyxia by submersion* or *drowning* is perhaps the most common, and one of the most interesting in the phenomena which it presents. It differs according as the submersion is complete from the first, or the person has risen again and again to the surface. In the former case, we should expect the *post mortem* appearances to be unequivocal. When a person falls into water, and remains beneath the surface, an effort is made to inspire; but this is impracticable, in consequence of the medium being irrespirable. Water is, however, drawn in, but as soon as the fluid reaches the glottis, the muscles which close it contract spasmodically; little or no water can enter, and death takes place with the same phenomena as present themselves in strangulation. These, as we have before shown, are,—accumulation of blood in the pulmonary artery and right side of the heart, owing to the nonconversion of venous into arterial blood, and more or less vacuity in the pulmonary veins, and left side of the heart. Yet Dr. Roget (Art. *Asphyxia*, in *Cyclopædia of Pract. Med.*) strangely enough affirms, that where there is no struggle, the lungs will be but little distended, and will preserve their natural colour, and that there will be no great irregularity in the comparative quantities of blood contained in the arteries and veins. His description applies sufficiently well to those cases in which considerable struggling precedes death, whilst his narration of the appearances met with under the latter circumstances, might be transferred, with much propriety, to asphyxia from submersion where there has been no struggling.

It is an important question of forensic medicine,—whether there are any intrinsic appearances about *the found drowned*, which can enable us—in the absence of all history of the case—to pronounce definitively, that death has taken place by drowning.

It has often been affirmed, that the presence of water, or, at all events, of frothy mucus, in the bronchial tubes, is characteristic of this variety of asphyxia. But dissidence has existed on this point amongst observers. At one time, the entrance of water into the bronchi was considered to be the essential cause of death, but it is now sufficiently established, both by experiments on animals, and by observation of the bodies of the drowned, that but little water is to be looked for;—generally, indeed, there is none; but there may be a small quantity of frothy mucus, totally insufficient, however, to account for death. Wepfer, Conrad, Becker, Waldschmidt, Littre, Petit, and others, have never met with water in the air tubes; and Morgagni, Haller, Evers, Desgranges, and others, assert, that, in their examination of several drowned persons, they have neither found water nor froth, although in other cases, some of these observers have met with both one and the other. Louis instituted several experiments with the view of testing this matter. On immersing animals in coloured liquids, he discovered them in the trachea, and sometimes even in the last bronchial ramifications. His experiments were repeated by Goodwyn, both for the purpose of proving that water positively enters the trachea, and of dispelling an idea, which had been entertained, that the frothy mucus is nothing more than a secretion from the bronchial tubes, owing to extreme engorgement of the pulmonary artery, during the last struggles of the individual. Three animals were immersed in mercury, and after death an appreciable quantity of the metal was found in the air passages. Experiments by Berger, Orfila, Piorry, and others, have led to similar results.

Admitting, then, that a small quantity of water may enter the bronchial tubes, we can readily understand, that if the individual were to rise to the surface and attempt to breathe, the inspired air, becoming mixed with the water and mucus of the bronchial tubes, might communicate the characters assigned to this frothy mucus; but it is not quite so easy to understand that any frothy mucus or liquid should be met with in the drowned unless under these conditions. If the individual, after immersion took in any fluid and remained beneath the surface, or, in other words, did not inspire afterwards, it could scarcely be frothy. This would appear to be the view embraced by Orfila. He is of opinion, that a greater or less quantity of water is generally drawn in during

the agony of drowning, and that the existence of froth in the bronchi depends, in a great measure, on the circumstance of the animal's having risen to the surface, and respired air once or twice previous to its final submersion. It need scarcely be added, that whenever froth is met with in the air passages, it is a proof, that the individual was immersed alive,—respiration being indispensable to mix the air with the liquid. The fact, however, of water being met with in the tubes is not a sufficient proof that the person came to his death by drowning. Messrs. Cox and Evers affirm, that if cats be first strangled, and then thrown into water, and suffered to remain there for 12 or 14 minutes, no water will be found in the lungs, except when the abdomen is compressed. In the latter case, the air and mucus being driven from the lungs, the liquid will be able to enter. Messrs. Orfila and Piorry have deduced, however, from their experiments, that in the case of dogs, killed by strangulation, and immersed in water a short time after death, water constantly enters the trachea, and may pass even to the last bronchial ramification, if the animal be kept in a vertical position, with the head upwards,—in other words, as if it had died from drowning. Hence, it may be inferred, that the entrance of water into the air passage, is not *necessarily* a vital act. Its presence in the trachea, bronchi, and even in the ultimate subdivisions of the bronchial tubes, is not a certain sign, that the person was living at the time of immersion, even if it should be shown, that the liquid is of the same nature as that in which he is found drowned. Still, as M. Devergie has remarked, this conclusion is not entirely rigorous, unless we infer, that the same results occur on man as on dogs.

Again,—it has been affirmed, that the presence of the frothy mucus is not of itself positive evidence of death from submersion, and that it has been observed in other kinds of death. Orfila says, it is not necessary that water should enter the trachea, in order that this frothy fluid should be found; and that the trachea of those who have been hanged always contains some of it. The first of these assertions has been confirmed by daily observation; but Devergie—although he does not deny the latter—asserts, that he has opened the bodies of thirteen individuals, who had been hanged, and that in none did he meet with frothy mucus in the trachea. He suggests, moreover, that it is important to have correct ideas respecting the nature of this froth, in order that it may not be confounded with frothy sputa. The froth of the drowned, he says, is commonly white, with very minute and numerous bubbles of air, constituting a foam (*mousse*) rather than a froth (*écume*). It never adheres to the trachea by the mucus, but is applied immediately to the tube. The same slightly viscid water, of which it is formed, attaches it to the trachea: all the bubbles that constitute it have a very fine aqueous envelope; they are readily divisible, and often, when the trachea is opened, the greater part subside like soap-bubbles. Whence, he concludes, the frothy water of the drowned has but little similitude to the sputa—either of pneumonia or of catarrh—and that attentive observation will prevent them from being confounded.

From all, then, that has been said, it is manifest, that although our knowledge on this matter needs some of that certainty, which is so desirable, the presence of frothy water, or of frothy mucus, does not perhaps afford us any unquestionable evidence that death has taken place from drowning rather than from any other form of asphyxia. Devergie is of opinion, that the strongest of the presumptive signs of drowning is the existence of a non-mucous froth or foam on the internal membrane of the trachea—itself in a sound state.

Again;—it was at one time thought, that the stomach would be found largely distended with fluid in cases of death from drowning; but this also is erroneous. Perhaps in all cases, some fluid will be swallowed, whilst the power of deglutition remains; but the convulsive action, induced in the muscles of the throat, will generally prevent much from passing. After death, it does not make its way into the stomach. The presence, therefore, of the fluid of immersion in that organ would be evidence, that the person had been thrown in alive; but the evidence loses much of its value, from the difficulty there must always be in establishing the identity between the fluid in the stomach, and that into which the body had been cast.

All these are interesting topics of medico-legal inquiry, which will be farther developed under another head. (See *Death, apparent.*)

A fluid state of the blood has been considered, by almost all writers on this subject, as an evidence of death from drowning. It would be a singular circumstance were this the fact;—unaccountable, indeed, unless we were to consider, that the fluid

of immersion were to penetrate the tissues to mix with one of its solutions, and we know the avidity with which water will penetrate animal membranes to accomplish this. In canvassing this point, Devergie states properly, that the existence of coagula in the vessels of the drowned is very uncommon, and that the fluidity of the blood is such, that it flows like water,—but he judiciously adds,—this fluidity ought to be common in cases of sudden death; and he says, that he has found it so in a number of persons, who had destroyed themselves otherwise than by submersion. Such, also, has been the result of the observations we have made on the subject.

Of the general impracticability of resuscitation in cases of asphyxia by drowning—where the causes have been fully and effectively applied—even a few minutes after the cessation of respiration, mention has already been made (p. 470.), when treating of asphyxia in general. Allusion was also made to fabulous narrations of restoration after a long immersion. It is but too true, however, that an immersion of a few minutes only will often seal the fate of the sufferer. It has been asserted, that if the submersion has not exceeded five minutes, and no blow against a stone, or other violence, has occurred to complicate the effects, the efforts at resuscitation, if properly conducted, will generally be successful. After a quarter of an hour, recovery is not very common; after twenty minutes, or half an hour, it may be considered hopeless. The longest period recorded in the Reports of the Royal Humane Society is three quarters of an hour; and from the first report of the establishment for the recovery of drowned persons in Paris, it would appear, that out of 23 cases restored to life, one had been three quarters of an hour under water; four, half an hour; and three, a quarter of an hour; the rest for a much shorter time. (Roget. *Loc. Cit.*)

Perhaps the safest rule is to attempt resuscitation, unless the signs which characterize the existence of *Death* (q. v.) are present,—according to some, unless putrefaction, or cadaveric rigidity, has supervened; but the humane practitioner requires no guide of this sort. He must judge according to his best powers of discrimination, whether the case is one of asphyxia, or of permanent privation of vitality, and if any doubt remains on his mind, his efforts must be continued until the doubt is removed.

As regards the *treatment* of this form of asphyxia, much need not be said, in consequence of the immediate application which the remarks made on the general treatment of asphyxia have to this variety. The rules to be adopted may be summarily expressed as follows:—

When the body is taken from the water, the mouth and nostrils should be cleansed, and if frothy mucus exist in the fauces it may be removed by the finger enveloped in a handkerchief. The wet clothes should be removed; the body be wiped dry, and be wrapped in a dry blanket: in this way it can be taken to the nearest habitation, on a board, or in a cart. When the body has been conveyed to a room, admitting of a good fire, if the water has been colder than the medium temperature of the climate, it may be stripped, placed upon a sofa, table, or on a board supported on chairs, before the fire, at such a distance, that the radiant heat does not act too powerfully upon it; whilst the air of the apartment is not above 75° or 80°. (Kay. p. 52.) A greater degree of heat than this is noxious, for reasons before mentioned; and it has been properly observed, that great caution should be used in the application of an elevated temperature to even a part of the body, excepting to the extremities—and they ought not perhaps to be excepted—lest the vital power of some important organ should be thereby enfeebled.

Such is the course, as regards the application of warmth to the body, most commonly pursued; yet, as we have previously seen, it has been a matter of question with some, whether the temperature of the body should not be kept depressed even when that of the atmosphere is low, until respiration has been restored by insufflation. Whatever doubts may exist on this point, there can be none, that any undue elevation of temperature is positively injurious, and that temperature, as Dr. Kay has observed, must be regarded as exerting chiefly a *conservative* influence.

As soon as the body has been placed in the favourable circumstances mentioned, attempts must be made to re-excite respiration, during which the head and chest should be kept raised, and the nostrils and mouth cleansed and open.

From what has been before said, the rationale of the following recommendations will be obvious. Let the individual be so exposed, that the atmosphere can act on the body; employ friction; and artificial respiration according to the plans previously advised, by means of the bandage, and the instrument of Leroy or any other

at hand, with the precautions that have been pointed out, lest serious mischief be done to the delicate fabric of the lungs.

Whilst artificial respiration is carried on, and especially if there be signs of returning animation, the warmth of the patient may be somewhat increased, and bottles of warm water, or warm bricks or warm flannels, may be applied to the feet, knees, armpits, pit of the stomach, and along the spine. The warmth of a healthy person lying by the body is said, in the Report of the Royal Humane Society, to have been found, in some cases of adults, but particularly of children, very efficacious. In the same report it is affirmed, that the warm bath, where it can be procured, is preferable to all other means of communicating heat; but the obvious objection to it is, that free exposure to the air is prevented, whilst the experiments of Edwards have established, that water exerts an injurious influence on the nervous and muscular systems.

As respects the use of stimulants, blood-letting, and other agents—often had recourse to in this and in other forms of asphyxia—what has been already observed, when touching on the treatment of asphyxia in general, is sufficient, and the same may be said of the means that are necessary after recovery.

It need scarcely be remarked, that the absurd practice of hanging up the drowned by the heels when first taken out of the water, and of rolling them on casks, ought to be universally reprobated. They were introduced at a period when death from drowning was supposed to be owing to the entrance of water into the chest and abdomen. If, in the language of the motto adopted by the Royal Humane Society, "*lateat scintillula forsan*"—the feeble spark could scarcely fail to be extinguished by such treatment.

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b. The phenomena of death from *hanging* and *strangling* are identical, so far as regards the intrinsic evidences. The extrinsic differ somewhat, in consequence of the situation of the cord, which, in the latter case is horizontal; in the former, more vertical. It can be understood, too, that in the former there may be dislocation of the cervical vertebræ, whilst in the latter this is not to be expected; but more mischief may be observable in the rings of the trachea, owing to the violence with which the rope is tightened with the view of rendering death certain; for strangulation is *primâ facie* evidence of homicide; hanging, of suicide,—it not being a very easy matter to hang a person against his will. Occasionally, too, strangulation has been effected by putting a stone or a coal in a handkerchief, and tightening it so that the coal may press upon and obstruct the wind-pipe; and cases have occurred of manual strangulation, the evidences of which have been apparent in the ecchymosis produced wherever the points of the fingers have pressed. All these varieties, as well as the mode of discriminating between them, will be canvassed under an appropriate head. (See *Death.*)

It is obvious, that the intrinsic phenomena must differ in these cases, according as the ligature is effectually or imperfectly applied; and, again, a difference may exist as regards the *ratio moriendi*,—whether, for example, death has begun in the lungs, or whether, owing to the dislocation of the vertebræ and consequent injury to the spinal marrow, the organs of innervation have been the first to be deprived of vitality. (See *Death.*)

Now, as injury to the spinal marrow could not be easily induced in death by strangulation, this must be esteemed as the more simple form of the two.

Of old, the idea generally entertained, was, that death in strangulation was caused by the cord pressing on the jugular veins, and thus interrupting the return of

blood from the encephalon, whilst its transmission to the brain by the vertebral arteries was uninterrupted. Engorgement of the cerebral vessels consequently supervened, and apoplexy. The striking objections to this view were,—that these very vessels may be tied without producing fatal apoplexy or apoplexy at all. Even the vertebral arteries have been tied, along with the jugulars and carotids, on animals,—and yet they have survived the operation. In some experiments, in which Dr. KAY included both the carotid and vertebral arteries in ligatures, one or two of the animals recovered, although they were exceedingly weak for some time after the operation. (*Op. Cit.* p. 284.) Again,—Dr. KELLIE tied the common jugular and the recurrent veins low down in the neck on two dogs, one of which appeared to suffer no inconvenience; the other, although rather dull and heavy for two days, speedily recovered. (*Edinburgh Med.-Chirurg. Trans.* I. 162.)

Another strong objection is the well-known experiment of Dr. MONRO, senr., who suspended a dog after having made an opening into its trachea below the place where the cord encircled the animal's neck. Through this aperture the dog breathed freely during the period of suspension, which was three quarters of an hour. He was then cut down, and did not appear to have sustained any serious injury. When, however, the cord was placed below the orifice, and the suspension was renewed, he soon died. (CURRY. *Popular Observations*, &c. p. 71.)

The works on medical jurisprudence refer to cases, in which attempts have been made to save the lives of criminals, by making an opening into the trachea. (MAHON, *Médecine légale*, &c. III. 62. FODÉRÉ, *Traité de Méd. lég.*, &c. II. 521. &c. &c.) A well-known case of this kind is that of GORDON, who, at the commencement of the last century, was sentenced to be hanged for highway robbery. He had become very rich by his avocation, and offered a large bribe to induce a young surgeon to attempt to defraud the law of its victim. An incision was made in his neck, and a tube was introduced through it into the trachea, in such a manner, that respiration might go on, if the upper part of the neck were constricted by the cord. The man was, however, very heavy, and it was considered, that other accidents, besides the mere interruption of respiration, were produced by the fall, for when the body had been suspended the accustomed time, and was cut down, and handed over to the friends, the surgeon drew blood from the jugular vein, and used the utmost exertion to resuscitate him, but in vain. Some slight evidence of vitality was manifested. Once he opened his eyes and sighed; but this was all.

Moreover, it is by no means proved, that any kind of congestion of the encephalon occurs in death from strangulation or hanging. The affirmative view has doubtless been embraced, chiefly in consequence of the marked turgescence of the vessels of the integuments of the head and face. After death from hanging and strangulation, the vessels of the scalp, and of the integuments of the head and neck, are gorged with blood, as well as those of the mucous membranes of the eyes, nostrils, and lips, and not unfrequently blood exudes from the nose and mouth. From these outward signs of polyæmia, it was inferred, that similar engorgement of the encephalon existed; but, although MORGAGNI, DE HAEN, and others, directed their attention for a long time to the subject, they did not discover any signs of engorgement in the brains of such as had died by suspension; and the observations of COLEMAN on animals, and of MONRO and KELLIE on the bodies of criminals, who had died on the gallows, confirm their assertions. Neither is there any appearance of congestion in animals that are killed after a ligature has been put on both the internal jugular veins, or when these vessels have been obliterated by the pressure of tumours.

Taking all these facts, then, into consideration, we are justified, we think, in inferring, that the ligature of the vessels of the neck does not occasion immediate death, and that the constriction by the cord, in suspension and strangulation, does not produce engorgement of the vessels of the brain. We have, therefore, to look for another chief cause of death. This is, doubtless, as had been occasionally suggested (BELLOC, *Cours de Méd. leg.* p. 199.), and has recently been much insisted upon by Dr. KAY (*Op. Cit.* p. 288.), the interruption of respiration.

The duration of life, in these cases, may be modified, as has been already suggested, by various circumstances,—such as the mode in which the rope is fixed; the height from which the body has to fall; &c. A humane executioner can expedite death by adding his weight to that of the criminal, so as to luxate the vertebræ of the neck; and LOUIS found, that the Parisian executioner could generally occasion death without a struggle, by rup-

turing the ligaments which unite the first and second vertebræ, or the ligament which confines the processus dentatus of the latter, so as to occasion pressure on the spinal cord.

It may be laid down as a general rule, that death will supervene in a longer or shorter period, according as the obliteration of the air passages is more or less complete. Sometimes, as already remarked, the rope may be placed between the lower jaw and the larynx, or in such a position, that a small supply of air may enter the lungs; or unusual rigidity of the cartilages of the larynx may exist, so as to permit air to enter—if not in sufficient quantity to maintain life, at all events to prolong the sufferings. This is often the case with those who attempt to destroy themselves.

The interruption, therefore, to respiration, must be regarded as the chief cause of death from suspension; yet, as Dr. Kay has observed, the condition of the sanguiferous system is considerably modified in this form of asphyxia, and the circulation in the brain is somewhat affected, though congestion may not be induced. The sphincters are frequently relaxed; the urine and fæces consequently escape, and there is often erection of the penis with emission of semen. The cause of these different symptoms has been a topic of inquiry. Orfila attributes the last symptom to traction of the spinal cord, consequent on the extension of the ligaments of the vertebral articulations; and in support of the opinion, he affirms, that erection is a frequent consequence of traumatic affections of the cord: he cites, also, a case in which it occurred in consequence of luxation of the fifth cervical vertebra. Dr. Kay—and we suppose every phrenologist will join with him—is inclined to attribute it to some vascular disturbance of the cerebellum.

In some animals, the ligaments of the spine can be readily stretched so as to cause death. Every cook knows that this is the case with the rabbit,—and we may readily conceive, with Orfila, that death might be produced in this way in man also.

We have before referred to some of the accidents, that occasionally complicate asphyxia by suspension;—the injury to the larynx, &c. There have also been cases in which true apoplexy has occurred,—effusion of blood having taken place on the brain; but these appearances present themselves in a few instances only. They are by no means to be looked for in simple cases of asphyxia from hanging or strangulation.

In a manuscript note, furnished by Sir Benjamin Brodie to Dr. Paris (*Med. Jurisprudence*, II. 44.), it is stated as the opinion of that distinguished surgeon, that if an animal should recover from the direct consequence of strangulation, it may probably suffer from the effects of the ligature on the nerves afterwards. Sir Benjamin passed a ligature around the trachea of a Guinea-pig, and tied it firmly on the back of the neck with a knot: the animal was uneasy, but nevertheless breathed and moved about: at the end of fifteen minutes, the ligature was removed; but on the following morning the animal died. On dissection, no preternatural appearances were discovered in the brain, but the lungs were dark and turgid with blood, and presented an appearance similar to that which is observed after the division of the pneumogastric nerves. "I do not," says Sir Benjamin, "positively conclude from this experiment, that the animal died from an injury inflicted on the nerves of the eighth pair, but I think that such a conclusion is highly probable, and it becomes an object of inquiry, whether a patient, having recovered from hanging, may not, in some instances, die afterwards from the injury of the par vagum."

With regard to the *treatment* of asphyxia from suspension—or strangulation—it does not differ much from that which is applicable to asphyxia in general. The chief modification demanded is the state of engorgement of the venous system of the outward head, produced by the constriction of the cord. The ligature must be removed immediately from the neck, and the head and shoulders be elevated: the body should be stripped, and exposed freely to the air, even when the temperature is somewhat low. The application of heat is the more unnecessary in this case, as the body has not been immersed in a cold medium, as in cases of drowning. Artificial respiration must be adopted as soon as possible, with the other agencies and cautions that have been already advised. Bleeding may be useful, to relieve the turgescence of the external vessels,—but only for this purpose. Especial care must be taken not to extinguish the flickering spark of vitality, and it need scarcely be observed, that during recovery, the abstraction of blood may be practised with great advantage, should symptoms of irregular vascular action about the head seem to indicate its employment.

c. Asphyxia from *smothering* does not differ, in its essential phenomena, from the other varieties. Except in the case of children, and even in them, it may be regarded as a rare occurrence. Occasionally it occurs to them as an accident, or perpetrated as a crime. It is possible, too, for an adult, in a state of intoxication or great debility, to get into such a position as to prevent the entrance of air into the air passages. Death, too, is not unfrequently produced by what is called 'overlaying children,' which does only mean that they are smothered by the mother lying upon them. Fatal accidents have happened from the young infant being pressed too closely against the side of the mother during her sleep, so that respiration has been arrested; and it has happened, that fatal asphyxia has been caused by the anxious care of the mother to wrap her infant so as to shield it against the inclemency of the weather. (*Annual Register*, for 1816. Chronicle, p. 147; and SMITH'S *Forensic Medicine*, 2d edit. pp. 246 and 249.) Children, again, have been smothered by being folded up in a sort of turn-up bedstead, once much employed by the poorer classes especially,—in a double capacity,—

"A bed by night; a chest of drawers by day."

The same differences may occur in this variety of asphyxia as in those that have been considered,—according as the condition has been induced at once, or as respiration may have gone on, though imperfectly, for a time.

As to the *treatment*, it is precisely that which has been laid down under the former heads, with the exception of the means demanded for their peculiarities. Asphyxia from smothering may, indeed, be looked upon as the most simple form: to it, therefore, the directions for the management of asphyxia in general are strikingly appropriate.

d. Among the causes that give rise to asphyxia, by preventing the entrance of air into the lungs, are enumerated;—obstruction of the air passages by the entrance of extraneous bodies, by the presence of tumours, or by any morbid thickening of the lining membrane of the tubes. For an account of the pathological phenomena, which are consequences of morbid actions going on in the parts, we must refer to those articles of the 'Cyclopedia' which are devoted to the consideration of such lesions. It need scarcely be said, that if such extraneous bodies or morbid conditions shut off the air at once, simple asphyxia is produced; if more slowly, the phenomena—as in other varieties of asphyxia—must be modified by the circumstance, and that the cases will have to be treated—medically or surgically—according to rules laid down under the appropriate heads. The same may be said of asphyxia produced by wounds in the parietes of the chest, which admit the air freely into the cavities of the pleura, and occasion contraction of the lungs.

By those who have employed the term 'Asphyxia' in its wide acceptation, many other varieties have been admitted. Thus, MOST (Art. *Asphyxia*, in *Encyklopädie* u. s. w.) enumerates Asphyxia from drinking; A. from poisons; A. from cold; A. from lightning; A. from hemorrhage; A. from violent passions or emotions; A. from concussion or contusion; A. from luxation of the cervical vertebræ; &c.; but, according to the definition of asphyxia, given in this article, their consideration would manifestly be out of place here;—the first link in the chain of morbid phenomena being seated in the functions of innervation or circulation, rather than in that of respiration; yet Dr. KAY, who, as we have seen, has so well explained the theory of asphyxia, has indulged in an episode on Death from cold (see *Cold*), which is as much out of place as would have been Death from apoplexy, or many of those other varieties that have been admitted by MOST, WAGNER, and such as allow a more extended acceptation to the term. There is a form of asphyxia, however, which may, with much propriety, be considered in this place,—according to the views which we embrace of its theory and phenomena. We allude to the *Asphyxia of the new-born infant.*

e. It is well known, that during intra-uterine life, no more blood passes through the lungs than is necessary for their nutrition, and that the blood of the fœtus is sent to the placenta, whence it passes back by the umbilical vein; doubtless after having experienced some changes in the placenta, which better adapt it for the nutrition of the new being.

The precise mode, in which the nutrition of the fœtus is accomplished, has been a topic of discussion amongst physiologists for ages. The facts and arguments appear to us decidedly in favour of the view which considers, that the human placenta has no direct agency in embyotrophy, and it seems to us, that all that is necessary—in order that a fœtus shall be developed in utero—is, that there shall be an absorbing surface surrounded by a nutritive sub-

stance, which will admit of being absorbed. Now, the cutaneous envelope of the fœtus—monstrous or natural—is such a surface, and the liquor amnii such a fluid; whilst the matter of the umbilical vesicle, and the jelly of the cord, when these parts exist, and *possibly* some material derived through the placenta—after it exists—may lend their aid, but the participation of the last organ is certainly questionable. Its function is probably to admit of the fœtal blood being shown to that circulating in the maternal vessels, in order that some change may be effected in the former, which may better adapt it for serving as the pabulum, whence the secretions from which the fœtal organs have to be elaborated, must be formed. (*Human Physiology*, II. 405. 2d. edit.; and *American Journ. Med. Sc.* No. 28, for August, 1834. p. 411.) The placenta, in other words, may be esteemed a respiratory organ for the fœtus; and yet its presence does not appear to be indispensable, as there are many well authenticated cases of children having undergone intra-uterine development, in the absence of umbilical cord, umbilicus, and placenta. Still, when these parts have once existed, they are necessary for complete fœtal development, and anything that interferes with the due passage of the blood along the cord, will produce asphyxia,—not only by preventing the requisite changes of the blood in the placenta, but by the interference with the circulation, which has to be effected by the umbilical cord and placenta, until the independent circulation is established by pulmonary respiration. (Velpeau, *Traité élémentaire de l'art des accouchemens*, &c. p. 925.) We can thus understand, that if the cord comes down in such a manner as to be strongly compressed for some time before delivery, asphyxia may be produced;—should the cord, for example, descend before, or with, the head. In like manner, when the breech, feet, or knees, present, there is danger to the child, unless the delivery be rapid. Occasionally, too, the child is still-born, apparently in consequence of some morbid condition of the organs of innervation. Thus, owing to pressure of the child's head, in its passage through the pelvis, or to some modification in the encephalo-spinal centres, or in the nerves distributed to the respiratory organs, the function of respiration is not established, notwithstanding that the circulation appears to go on well along the cord: the child seems to be in an apoplectic condition.

Asphyxia may persist longer in the new-born child than in the adult, in consequence of the powers of calorification being but imperfectly developed, and there being, in consequence, less need for a highly oxygenized blood for its support.

It has been a question, whether the umbilical cord should be divided in these cases as soon as the child is extruded. In reply to this it may be remarked, that if all circulation has ceased in the cord, there can be no advantage whatever, in keeping the connexion between the child and the placenta entire, especially as the union cannot fail to interfere with the due application of such means as may be regarded necessary. Indeed, where the circulation continues, but is becoming weaker, whilst the breathing has not commenced, it has been properly doubted, whether if the connexion with the mother interfere with the application of other efficacious means, it should be permitted to continue, when, owing to the placental circulation having become weaker, it seems evident that the application of such means cannot be longer delayed with impunity. (Kay, *Op. Cit.* p. 89.)

Sometimes, when the child is extruded and the placental circulation continuing, the stimulus of a smart stroke on the breech will arouse the dormant energies, and the child will immediately begin to cry; but if this is insufficient, the infant had better be exposed to a moderately warm temperature, that is, to the moderate warmth of the fire, but so that the air can come in contact with a large surface of the body. Edwards found that the young of some species of warm-blooded animals, when deprived of air, live longest in a temperature of about 68° Fahrenheit, and this may be taken as a guide to the proper temperature for the still-born infant. Generally, immersion in a warm bath is had recourse to, but the rationale of its action is by no means unequivocal, whilst, as Dr. Kay has observed, it is not necessary to the application of a proper degree of warmth to the body of the child; it prevents the beneficial effects of the atmosphere on the skin; and, moreover, it is found, as we have seen, to exert a depressing influence on the nervous and muscular systems.

In addition to these means, friction with the dry hand, or with stimulating liniments, especially over the regions of the chest and stomach, as well as the application of spirits to the nostrils, to rouse the respiratory nerves to action, have been recommended. Should any mucus obstruct the mouth and pharynx, it ought to be re-

moved by means of the finger enveloped in a piece of fine linen, dry or dipped in a solution of common salt.

But, after all, these means will often be found unsuccessful, and it becomes necessary to have recourse to artificial respiration. This is, indeed, the great reliance of the practitioner in severe cases, and its salutary influence is frequently very marked. Whilst artificial respiration is persisted in, the cord will often be observed to pulsate, and to cease when the operation is suspended. In the still-born fœtus, it is not found practicable to execute artificial respiration by mere pressure on the chest, in the mode recommended for the adult. In one case, Dr. Blundell (*The Principles and Practice of Obstetricy*, Amer. edit. p. 162.) diligently operated in that manner for fifteen or twenty minutes together, without producing resuscitation, and, on examining the child on the following day, he found that scarcely a particle of air had entered the lungs. Nor can insufflation be readily effected by blowing in at the mouth. The only mode of doing it effectually is by means of the curved canula or some analogous instrument. We are in the habit of carrying a tracheal pipe, of which the annexed figure is a representation. It is a little tube of silver, with its extremity closed, and an aperture near the extremity to give passage to the air and mucus. The introduction of this instrument into the larynx is by no means difficult, with a little care. All that is necessary is, to pass the forefinger of the left hand upon the root of the tongue as far as the opening of the larynx, and then to insert the tube, held in the right hand, along the finger as a director. It will readily enter, and by pressing on the neck, it can easily be discovered, whether the instrument is in the trachea or the œsophagus. The lungs may then be inflated by blowing air from the lungs of the practitioner through the tube, and then forcing it out again by pressing on the thorax and abdomen, and repeating this five and twenty or thirty times in a minute,—the respirations of the new-born infant being as numerous as that. It has been objected, that the air, sent into the lungs of the fœtus from those of the adult, cannot be as efficacious as pure atmospheric air; but it is to be borne in mind, that the young being does not require such highly oxygenized air as the adult; and moreover, Héroldt found, that air inspired, and expired immediately afterwards, had only one hundredth part less of oxygen than common atmospheric air. This objection, therefore, is more plausible than real. In inflating, care must be taken, as we have previously inculcated, that it is not driven in too powerfully. The experiments of Leroy d'Etioles show, that insufflation may be performed with much less risk in the infant than in the adult, because the structure of the lungs is firmer in the former, and consequently there is less danger of rupture or dilatation of the air cells.

If the bellows of Leroy are at hand, which they scarcely ever are, on such occasions, they may be employed. It has also been proposed, that a small galvanic apparatus, like that recommended by Leroy, and before described, might be used with advantage to rouse the diaphragm to contraction. "The acupuncture needles might be introduced into the diaphragm, one or two lines on each side of the chest, and two wires, each leading to an opposite pole of the galvanic circle, might be connected with these needles. On completing the galvanic circle, a contraction of the diaphragm would be produced, which might be suspended by removing one wire, for a moment, from its connexion with the battery. The relaxation of the muscle might then be effected by gentle pressure on the abdomen, and this process might be alternately repeated until respiration was established." (Kay, *Op. Cit.* p. 93.)

Such appears to be the most approved mode of resuscitation in cases of the *Asphyxia neonatorum*. Désormeaux, however (Art. *Nouveau-nés*, in *Dict. de Méd.*; and Velpeau, *Op. Cit.*), complains of his want of success from inflating the lungs, even when assiduously used, and he places his main reliance on external means for exciting the respiratory muscles to contract. For this purpose, he recommends a species of *douche* or ablution with some alcoholic liquor. This the practitioner takes into his mouth, and having held it there a few seconds, he ejects it forcibly against the anterior paries of the infant's chest. It is rarely necessary, he says, to repeat this more than twice or

thrice. Velpeau says he has adopted the plan, and with success.

It has been also advised, that a cupping-glass should be applied to the nipples of the child, or that they should be sucked by the mouth (Van Swieten, Saccombe, and also Wagner, in *Encyclopädisches Wörterbuch*, &c. Band III. s. 557.); but, as Désormeaux has remarked, the only use in this can be to excite the action of the muscles. It is utterly impossible, that any dilatation of the chest could be produced by it, as has been believed by many, who were more credulous than judicious. (Velpeau, *Op. Cit.* p. 927.)

It is unnecessary to dwell upon the many other expedients that have been occasionally adopted. If the means pointed out should fail, we ought not to expect advantage from such agents as the smoke of linen or burnt paper, or onions or garlic introduced into the rectum, or the application of stimulants to the nose. Their cautious use may be advisable when the spark begins to be ignited, but not before.

When the means are beginning to succeed, the pulsations of the heart and of the cord—if the child be still attached—gradually return; the muscles resume, by degrees, their natural firmness; the skin becomes less pale, and calorification is re-established. Some slight convulsive gasps are made, which become stronger and stronger, and ultimately the child attains sufficient vigour to cry, after which it may be looked upon as safe. This, at least, is a general rule; but every practitioner must have had the mortification to find, that even when he has succeeded so far, unfavourable symptoms have presented themselves, and the child has sunk. Velpeau refers to two cases in which he had succeeded in restoring the movements of the heart and the lungs for more than three hours, by means of insufflation and galvanism; yet both infants were subsequently lost.

The same question has been agitated here, as in other cases of asphyxia:—How long ought we to persevere in our efforts at resuscitation? It has been advised, that they should not be relinquished under two or three hours,—but all this must be decided upon by the good sense of the practitioner. Let him bear in mind, that many a child has been thrown aside as dead, which might probably have been saved. A woman, run over by a stage, was carried into St. Thomas's Hospital, London, and died in a few minutes after admission. Dr. Blundell was requested by Mr. Green to assist in the Cæsarean section. In thirteen minutes from the last respiration of the mother, the child was taken out. In fifteen minutes from the last respiration of the mother, Dr. Blundell began the artificial respiration, and, during fifteen minutes longer, he continued it. Ultimately, the child was completely resuscitated, and, according to Blundell, if due care had been taken of it, it would probably have been living still. He affirms, also (*Op. Cit.* p. 164.), that a Mr. Tomkins of Yeovil, a gentleman very accurate in his observations, used resuscitants for an hour and five minutes by the watch, before obvious signs of life appeared. The child recovered, and lived for some time afterwards.

Still, much must be left to the judgment of the practitioner. Where, from the appearance of the fœtus or other evidences, he has reason to believe, that it has been for some time dead in utero, all his endeavours must necessarily be abortive. It is only in cases in which the child has perished in the birth, that means can be available,—and in such case all the energetic measures, which we have recommended, should be put in force, and not abandoned until all hope is lost. Mr. Burns says, that when a child does not breathe soon after it is born, it is not always easy to say whether it is alive, as we have, at this time, no criterion of death except putrefaction; and therefore, that it behooves us always, unless this mark is present, to use means for preserving the child. His remark might be extended to every case of apparent death happening at any age, but there is generally a catenation of phenomena, which enables us to pronounce with tolerable certainty before this criterion of death is observable. (*Principles of Midwifery*, Book iv. chap. 1. sect. 1.) There can be no doubt, however, that so long as there is any hesitation in the mind of the practitioner as to whether the child is dead or not, his efforts should be perseveringly continued.

Where there is any reason to believe that the state of suspended animation is dependent on, or connected with, an apoplectic condition,—as where the respiration is very slow and laborious, and there is evidence of venous engorgement of the head and neck, with pulsation in the cord—advantage is often derived from permitting a tea-spoonful or two of blood to flow.

Where the attempts at resuscitation have been successful, in the case of asphyxia of the new-born, the same atten-

tion is necessary during recovery—that is, for a day or two afterwards—as in the varieties of asphyxia previously considered.

Bibliography.—The different writers on Obstetrics.

Robley Dunglison.

ASPIDIUM. (*Botany.*)

A genus of ferns, separated from *Polypodium*, from having the fructification covered with an involucrum. It contains several species that have been employed as therapeutic agents, and have attained much celebrity as anthelmintics, &c., more especially the *A. filix mas.*

A. filix mas. Male fern. *Fougère mâle*, Fr.; *Johanniswurzel*, Germ. *Sp. Ch.* Fronds bipinnate; pinnules oblong obtuse, serrated; serratures mutic; sori near the central nerve; stipe and rachis chaffy. Hooker. The male fern is found in most parts of the world, and is abundant in certain districts in the United States, principally in shady pine forests. The American plant is said by Pursh to have the leaflets more obtuse, and oftener doubly serrate than the European: this, however, is not invariably the case, as specimens are often found agreeing in every particular with those from England, &c.

The root, which is the officinal part, is perennial, but the fronds are annual. This root, which is in fact a true rhizome, is horizontal, and consists of tuberculated portions, connected by a common axis, and separated from each other by membranaceous, silky scales of a brown colour. The radicles or true roots issue from the extremities of these tubercles. The fronds or leaves are numerous, and are from one to three feet in length. The footstalk is of a brown colour and covered with brown membranaceous scales. The frond is bipinnate, of a bright green colour. The leaflets are deeply divided into lobes of an ovate form, cuneate and gradually diminished in size as they approach the extremity of the leaf. The fructification is borne on the back of each lobe, and consists of rows of small brown dots situated near the middle nervure. (See *Felix mas.*)

The *A. barometz*, or Sythian lamb, respecting which so many absurd fables have been propagated, has roots which are covered with fine brown scales resembling hair. These rhizomes are of a large size, and are highly esteemed in China as an astringent in external hemorrhages, as well as in diarrhœa and other discharges.

The *Cahahuala* of Peru, in such general use among the natives, in rheumatic and syphilitic affections, and spoken of in exalted terms by Ruiz and other Spanish authors, as a remedy in pleurisy, and, in fact, in almost every disease, appears to be either a species of *Aspidium* or of *Polypodium*, though the accounts given of it are too vague and confused to determine the point with certainty.

R. E. Griffith.

ASPLENIUM. (*Botany* and *Mat. Med.*)

Gen. Ch. *Sori* linear, transverse, scattered. *Involucri* arising from the lateral veins, and opening towards the central nerve or rib. Hooker.

This genus of ferns is not very numerous, though its different species are found in most parts of the world, on rocks and old walls. In its medical properties it closely resembles Adiantum (q. v.), but does not possess the aroma of the officinal species of that genus. At one time the *A. ruta muraria* was highly esteemed and considered as a panacea in all inflammatory disorders. As, however, the only qualities it possesses are those of a mild astringent and demulcent, it is at present only employed as a substitute for the true Maiden-hair in making capillaire. None of the species are recognized in the U. States Pharmacopœia, but several are considered as officinal by the French and German. Descourtilz states that the *A. serratum*, a native of the West Indies, has been found useful in obstinate diarrhœas, in doses of one to three drachms. (*Flore Med. des Antilles*, II. 337.)

R. E. Griffith.

ASSAFETIDA. — Assafœtida, Ph. U. S.—*Assafœtida*, Fr.; *Stinkasant*, *Teufelsdreck*, Germ.

Origin, and *Commercial History.* Assafetida is the concrete juice of the *Ferula Assafœtida*, an umbelliferous plant growing in Persia and the countries which border upon that kingdom upon the east. (See *Ferula.*) In the *Amenitates Exoticæ* of Kaempfer, published in the beginning of the last century, after the return of that traveller from Asia, the following account is given of the mode in which the juice is collected in the mountains of Chorassan and Laar. In the choice of plants, the oldest are selected, as the young yield little juice; and it is never thought worth while to cut those which are less than four years old. At the season when the leaves begin to decay, the earth is cleared away from around the upper part of the root, which, when full grown, is as large as the arm or leg of a man. The stem and leaves are then twisted off, and, together with other vegetables, are placed over the root so as to

screen it from the sun, being retained in their situation by a large stone laid upon them. These are allowed to remain for forty days, after which they are removed, and the top of the root is cut off transversely. The surface thus exposed is protected from the sun by a covering of leaves for forty-eight hours, during which a portion of juice exudes. This is scraped off, and another transverse slice of the root is removed, in order to afford a fresh surface for exudation, from which the juice is collected as before. This operation is repeated several times, an interval of eight or ten days being allowed after the third section, in order that the root may have an opportunity to recruit. A period of nearly six weeks elapses before the root is quite exhausted. The juice, when collected, is exposed to the sun in order that it may harden; and as the product of different roots is put together by the peasants, the mass assumes that heterogeneous appearance which assafetida presents as it is ordinarily found in commerce. When sufficiently concrete, it is enclosed in mats, and sent to Bushire upon the Persian Gulf, whence it is shipped to Calcutta, and from that port is distributed over the world. It is imported into this country either in the original mats, or in cases in which it is packed at Calcutta.

Sensible properties, composition, &c. Assafetida is in masses of different sizes, and of variable consistence, according to its age and the degree of exposure to which it has been subjected. Sometimes it is rather soft and adhesive, sometimes hard and firm, requiring considerable force to break it. When quite dry, it is brittle, but not readily pulverizable, unless at a low temperature. It may be powdered in winter, and by sifting may be freed from the coarse impurities with which it is sometimes associated. Its fracture has a lustre like that of wax. The freshly broken surface is usually more or less diversified, exhibiting white, shining, smooth, homogeneous parts, intermingled with others of a darker colour and less uniform aspect; as if the mass consisted of separate portions agglutinated together.

The colour of assafetida, when recently broken, is whitish, but soon becomes reddish upon exposure, and gradually deepens into a violet red, which is ultimately changed to brown. The outer surface of the masses is usually yellowish or reddish-brown. The *odour* is peculiar, strong, fetid, and to most persons excessively disagreeable. It was this property which gained for the drug among the Germans the expressive name of *Teufelsdreck* or *Stercus Diaboli.* It is not difficult, however, to become reconciled to the odour, and there are not wanting individuals for whom it has strong attractions. It is much more powerful in the recent drug than in that which has been long exposed; and Kaempfer states that one drachm of the fresh juice emits a stronger smell than one hundred pounds of the concrete masses found in the shops. The *taste* is bitter, acrid, and durable.

Exposed to a moderate heat, assafetida softens and becomes adhesive, but never completely melts. It is inflammable, burning with a clear lively flame. It imparts its sensible properties and medical virtues to alcohol, forming a transparent tincture, which is rendered milky by the addition of water. Macerated with water it affords a reddish turbid solution, and triturated with that fluid, an opaque emulsion, which is at first white, but becomes of a pink colour upon exposure. After standing for some time, it deposits the resinous portion.

Assafetida is usually ranked among the gum-resins, and consists, according to the analysis of Brandes, of 4.6 parts of volatile oil, 47.25 of an odorous bitter resin soluble in ether, 1.6 of a tasteless resin insoluble in ether, 1.0 of extractive, 19.4 of gum containing traces of potassa and lime united with sulphuric, phosphoric, acetic, and malic acids, 6.4 of bassorin, 6.2 of sulphate of lime, 3.5 of carbonate of lime, 0.4 of oxide of iron and alumina, 0.4 of malate of lime with resin, 6.0 of water, and 4.6 of impurities consisting chiefly of sand and woody fibre. The proportion of the ingredients no doubt varies considerably in different specimens. The *volatile oil* is most abundant in the recent drug. It is upon this principle that the odour of assafetida depends. It may be obtained separate by distillation with water. It is limpid and colourless when fresh, but becomes yellow by age. Its specific gravity is less than that of water. Its odour is exceedingly powerful and offensive; its taste at first flat, but ultimately bitter and acrid. Water dissolves it but very slightly, alcohol and ether in all proportions. It is said to contain sulphur. The medical virtues of the drug reside in the volatile oil, and in the bitter resin; and it is a question whether the latter ingredient does not owe its efficacy to a small portion of the oil tenaciously combined with it.

In the selection of assafetida, those pieces should be preferred which are free

from obvious impurities, present when broken a white shining surface, and have in a high degree the peculiar odour of the gum-resin.

Effects upon the system. Assafetida is stimulant, antispasmodic, expectorant, laxative, and perhaps emmenagogue. Taken internally, it produces a feeling of warmth in the stomach, which is soon followed by a moderate excitement of the heart and arteries, increased heat of skin, and sometimes gentle diaphoresis. At the same time it exerts a powerful influence over the nervous system, which is evinced rather by its efficacy in relieving certain morbid conditions, than by any very obvious phenomena during health. It appears, however, sometimes to occasion mental excitement and exhilaration of spirits; and in large doses gives rise to swimming in the head, dizziness, and other indications of disturbance in the nervous functions. It is generally admitted to have an especial tendency to the pulmonary organs, and to stimulate the bronchial mucous membrane to increased secretion. Some believe that it exerts a peculiar influence over the uterine system, calming the irritations to which it is exposed, and promoting and sustaining the menstrual effort. Its stimulant action is also decidedly felt by the stomach and bowels, as is evinced by the local sense of warmth and the laxative effect which result from its use in the healthy state, and still more by its happy influence in certain debilitated conditions of these parts. In large doses it sometimes acts as a purgative. There is no reason to doubt that it is absorbed from the alimentary canal, and operates upon the general system through the medium of the circulation; for after it has been used for a short time, its odour is perceived in the breath, and in all the secretions, even those of a morbid character; and it is even asserted that sensitive individuals can perceive its taste in the mouth when it has been administered by the rectum.

Therapeutic applications. Assafetida was probably used by the ancients both as a medicine and a condiment. It is thought to have been the σιλφιον or οπος σιλφιου of the Greek writers, and the *laserpitium* or *laser* of the Latin. By the earlier modern medical writers it is commended as a remedy in nervous affections; and most practitioners at present agree with Boerhaave and Cullen in considering it as one of the most powerful antispasmodics. In Persia and India it is said to be less employed as a medicine than as a condiment. The Brahmins use it habitually to obviate the flatulence occasioned by their vegetable diet; and we are told by Ainslie that they consider it digestive and aphrodisiac.

This remedy is indicated in all spasmodic complaints and other cases of nervous derangement, unconnected with excitement of the circulatory system, or with local inflammation; and especially when these affections are associated with or dependent on general debility. Even in inflammatory complaints, when the nervous system is thrown into great agitation, the use of assafetida is frequently admissible after due depletion, or after the partial subsidence of excitement in the natural progress of the disorder. This remark is especially true of the pulmonary affections, in which the union of expectorant with antispasmodic properties renders the medicine peculiarly useful. Simply as a stimulant expectorant it will be found occasionally advantageous in chronic bronchial disease. Its excitant and laxative properties adapt it also admirably to certain morbid conditions of the alimentary canal, in which costiveness and flatulence are associated, as is frequently the case in old people, with deficient irritability of these parts. It is obviously contra-indicated in cases of general plethora, or inflammatory excitement, and especially by acute inflammation of the alimentary mucous membrane.

From these remarks it may be inferred that assafetida is very extensively applicable as a therapeutical agent. Without attempting to particularize every variety of morbid affection in which it has been employed or recommended, we shall indicate those complaints in which either decided indications for its use are presented, or respectable testimony to its favourable influence can be adduced.

In *hysterical disorders* assafetida is often highly advantageous. It probably acts here not only by its general influence upon the nervous system, but also by its fetid odour, which gives a new direction to the nervous irritation, and thus for a time relieves the existing symptoms. It is, however, only in the lighter forms of the complaint that it does good in the latter mode. In hysterical colic it will be found peculiarly useful. In certain conditions of hysteria, in which it is impossible to administer the remedy by the mouth, it may be advantageously given in the form of enema. Such are the convulsive paroxysms, and the conditions of insensibility more or less complete, which fre-

quently occur in this disease. Assafetida, however, must be regarded rather as a palliative than as a remedy in hysteria, and should be used only as an adjuvant to means directed to the root of the disorder. It may sometimes even do harm if employed without attention to the condition of the circulation, or to existing inflammatory affections.

The foregoing remarks are equally applicable to *hypochondriacal affections*, in the treatment of which assafetida has long enjoyed a high reputation. Persons of excitable nervous systems are occasionally subject to vertigo, dizziness, fainting spells, and various anomalous disorders of a nervous character, in all of which this medicine will prove useful if applied with proper discrimination.

In obstinate *singultus* it is perhaps next to musk the most effectual remedy.

In *infantile convulsions* dependent on intestinal spasm it is doubly useful, by relieving the local affection, and by controlling that excitable condition of the nervous system which renders it so liable, in children, to be thrown into irregular action by any local irritation. In the convulsions caused by dentition, worms, and other local affections unconnected with the brain, it sometimes acts favourably, if given in the intervals of the paroxysms, in preventing their return. Great care, however, is necessary in properly discriminating such cases from those purely cerebral, and in avoiding the risk of too much arterial excitement.

Cases of cures of *epilepsy* by means of assafetida are on record; and there is no doubt that in the purely nervous forms of this complaint it may occasionally prove useful.

In *chorea* it may sometimes be given advantageously, though in the majority of instances this disease is greatly beyond its reach. An obstinate case, which had resisted the most powerful remedies, was cured by the following combination:—

℞. Assafœtid., Extr. Valer. āā ℨii, Extr. Belladon. gr. v, Oxid. Zinci ℈i, Castor. gr. xxxv:—to be made into pills of two grains each, five of which are to be taken three times a day. (Günther, quoted by Richter, *Arzneimit.* II. 20.)

Assafetida has been used in *typhoid fevers*, and may be found advantageous in cases attended with nervous derangement without decided symptoms of cerebral disease or intestinal inflammation;—but in general its good effects may be more readily obtained from other less objectionable remedies, and it is now seldom employed. When given in these complaints, it is best administered in the form of enema; as its constitutional impression may thus be obtained with less danger of irritation to the mucous membrane of the stomach and small intestines.

But the complaints in which the powers of assafetida are most favourably exercised are the spasmodic pectoral affections. In *hooping-cough* it is one of the most effectual remedies to which we can have recourse. In this disease it was extolled by Millar, and has subsequently been much employed. In the different forms of *asthma* it will occasionally do good—in the *spasmodic*, by affording relief to the paroxysm, and in the variety usually denominated *humoral*, by its combined antispasmodic and expectorant properties. Dr. Chapman speaks in strong terms of its efficacy, when given in large and frequently repeated doses, in the asthmatic paroxysm. (*Elem. of Mat. Med. and Therap.* II. 297.) Cullen, however, states in his Mat. Med. that he has seldom found it of much service in this complaint. In *coughs* dependent upon nervous irritation, which are not very uncommon, we have often found the most decided benefit from assafetida; and *catarrhal affections*, which are sometimes rendered obstinate by such a complication, will, after due depletion, yield to this, sooner than to almost any other remedy. Dr. Joseph Parrish, of Philadelphia, has found it of the highest service in *infantile catarrhs* of this character. (*N. Amer. Med. and Surg. Journ.* I. 24.) In the inflammatory pectoral affections of very young children it not unfrequently happens, either from the depletion employed, or from the feeble resources of the system, that the strength gives way before the disease has had time to complete its course, and the patient sinks under a complaint the natural tendencies of which are towards recovery. The ordinary stimulants cannot be safely used, from the danger of rekindling the declining inflammation. Under these circumstances, assafetida exercises a most happy influence—imparting vigour to the nervous system, which most stands in need of support, and at the same time operating favourably upon the local disease by promoting expectoration. The author is entirely confident, that he has seen repeated recoveries under this treatment, in cases which, without such support, or under a continued system of depletion, must have proved fatal. It may be stated, as a general rule, that in all *chronic bronchial affections*, in which the secretion from the

mucous membrane is too abundant, and the lungs become loaded beyond the power of convenient expectoration, assafetida will do good, if given with a due regard to the state of the pulse and to the evidences of local inflammation. In the latter stages of phthisis it sometimes proves useful by facilitating expectoration and relieving dyspnœa.

In diseases of the abdominal viscera, assafetida may often be usefully employed as a stimulant antispasmodic and laxative. CULLEN observes that it is particularly useful in relieving those spasmodic complaints which so frequently attend *dyspepsia.* In costiveness accompanied with flatulence it may often be advantageously combined with tonic and cathartic medicines, particularly in the cases of elderly persons, and those of a weak, relaxed habit of body, with paleness of the surface, and other marks of a leucophlegmatic temperament. It is strongly recommended by RICHTER, in combination with ox-gall and rhubarb, in dyspepsia attended with acid in the stomach. He employs the following formula:—℞. Assafœtidæ, Fell. taur. inspiss. āā ʒii, Rhei pulv. ʒss:—to be made into pills of two grains each, twelve of which are to be taken three times a day. (RICHTER, *medic. chirurg. Bemerk.* I. 174.) The German physicians employ it in complaints dependent on obstruction in the portal system. In HUFELAND's Journal (III. 595.), a case of *jaundice*, approaching in character to the variety commonly called *black jaundice*, is stated to have been cured, after the fruitless employment of many other remedies, by a mixture composed of tincture of assafetida, golden sulphur of antimony, and oil of turpentine. As an anthelmintic, assafetida has enjoyed considerable reputation, but is now comparatively little employed; as, though not without some vermifuge power, it is inferior in this respect to many medicines which are less disagreeable to the palate. Still, it may occasionally be resorted to with advantage in cases of *worms*, when these are attended with symptoms of local or general nervous disorder.

Assafetida is by some writers extolled as a remedy in amenorrhœa, and other derangements of the uterine functions. Like most other stimulants it undoubtedly promotes the menstrual secretion, when made to co-operate with the natural tendencies of the system; and it may be used advantageously in cases which present the double indication for emmenagogue and antispasmodic medicine; but in cases of simple suppression or retention of the menses it cannot be relied on, and at best should be employed only as an adjuvant to other more efficient remedies.

The German medical writers ascribe considerable resolvent powers to assafetida, and recommend its employment, both internally and externally, in scrofulous tumours and other chronic swellings and indurations, and in venereal and scrofulous affections of the bones. By some it is even considered useful in caries. The probability is, that it does little other good in these affections than to afford a gentle support to the general vital powers, and to obviate those nervous disorders to which patients are incident in the course of most chronic complaints.

Dose, Preparations, &c. The dose of assafetida is from five to twenty grains; but in obstinate complaints attended with considerable insensibility, it may be increased to a drachm, two, three, or four times a day. In consequence of its unpleasant odour and taste, the form of *pill* is usually preferred when the dose is not large, and a tardy operation only is required. The pills may be made immediately from the mass if it be first softened by a moderate heat; but as, when thus prepared, they are not readily dissolved by the gastric liquors, a better plan is to incorporate the gum-resin with some substance, which may separate its particles and render it more readily soluble. The *Pilulæ Assafœtidæ*, of the U. S. Pharmacopœia, consist of three parts of the gum-resin and one part of soap. Each pill contains three grains of assafetida. Instead of soap, some soft extract, such as that of gentian, may be employed.

When the dose is large, or a speedy effect is demanded, the best form of administration is usually that of emulsion. This may be made by simply triturating the assafetida with water. Gum Arabic is sometimes added in order to render the suspension of the resinous portion more permanent. The *Mistura Assafœtidæ* of our national code contains two drachms of the gum-resin in half a pint of water, and may be given in the dose of one or two table-spoonfuls. From its opaque milky appearance it is often called *lac assafœtidæ* or *milk of assafetida.* This is the form in which the medicine is usually administered as an enema. From two to four fluidounces may be given in this way.

Another form in which assafetida is often administered is that of tincture. The officinal *Tinctura Assafœtidæ* is prepared with undiluted alcohol or rectified spirit

in the proportion of two ounces of the medicine to a pint of the menstruum. The medium dose is a fluidrachm. This form may be preferred in cases of torpor of the stomach or general debility; and is peculiarly adapted to the cases of drunkards.

GEO. B. WOOD.

ASSIMILATION. (From *assimilare*, to render similar.) The act by which living bodies convert into their own substance, foreign matters. It is the ultimate process of the series of actions which concur to effectuate the reparation of organized bodies, and constitutes an important part of the function of nutrition. (See *Animalization*, *Digestion*, and *Nutrition*.

I. H.

ASTHENIA. (From α priv. and σθενος, strength.) Want of strength, debility. This term, if regard be paid to its etymology, is perfectly synonymous with adynamia, but it has been frequently used in a more restricted sense to signify some form of this condition. It has not, however, been uniformly employed to denote the same species of debility: on the contrary, there is great discordance on this point, among writers; and therefore, to avoid the ambiguousness that exists as to its signification, we shall employ it only in its general acceptation, that which its etymology indicates. Our duty, nevertheless, as lexicographers, calls upon us to indicate the principal meanings which have been assigned to it. In the writings of HIPPOCRATES it signifies a deficiency in the system to resist the action of morbific causes. The ancient nosologists, who constituted a class of diseases named asthenic, understood by this appellation a debility of the whole organism or of some of its functions, without any reference to the powers of the system to resist pathological agencies. The celebrated BROWN gave to this term a meaning founded entirely upon his particular doctrine. According to him, there exists in the organism a single force, excitability, which, maintained at a certain point, constituted health; when below this point, asthenia. (See *Brunonism*.)

PINEL (*Dict. de Méd.* II. 401.) seems to have restricted this term almost exclusively to express the debility of old age. The author of the able article *Asthenia* in the *Dictionnaire abrégé des Sc. Méd.* defines it to be "that state of an organ in which the energy of its vital action is below the normal type," making it thus, as we have done, synonymous with debility. ROCHE (*Dict. de Méd. Prat.* III. 593.) gives it a similar definition, and includes under it the debility from old age, that resulting from venereal excesses, suckling, profuse suppurations and secretions, prolonged hemorrhages, insufficient alimentation, the exhaustion of the organs from excessive action, and finally, from marasmus, anesthesia and anemia; whilst LITTRÉ (*Dict. de Méd.* 2d ed. IV. 241.) restricts its signification to the "diminutions of the organic actions without either antecedent or concomitant appreciable lesion of the solids or liquids;" and especially insists upon the necessity of distinguishing from asthenia the debility which follows anemia, profuse hemorrhages or secretions, that which accompanies typhus, scurvy, purpura, &c.

As we propose under another head (see *Debility*) to investigate fully this interesting subject, it is unnecessary at present to expose more fully the views of the writers we have quoted, or to inquire into their justness.

I. H.

ASTHENIC. Appertaining to asthenia.

I. H.

ASTHMA. (From αω or αημι, I breathe, or rather, ασμαζω, I breathe with difficulty.) Ασθμα, Gr.; *Anhelatio*, Lat.; *Asma*, Ital.; *Asthme*, Fr.; *Die Engbrüstigheit, das keuchen*, Germ.

Difficult breathing, which constitutes the most prominent feature of this disease, seems to have attracted medical attention from the earliest antiquity. The Greek writers, as we learn from CELSUS, distinguished it according to its gradations,—calling it when moderate, *dyspnœa*—when more severe, *asthma*—and when of the utmost violence, *orthopnœa*. In the progress of time, these terms underwent considerable fluctuations in their meaning and applications, till finally that of Asthma was made to embrace every case of embarrassed respiration, whatever might be its nature, or the manner in which it was induced. But this condition presents such infinite varieties in these respects, that a more precise and limited definition was required. Later authorities, therefore, restrict its use to a peculiar form of this affection, recurring in paroxysms, each of which, having a quotidian aggravation, coming on towards evening, or in the night, and subsiding in the morning, usually with more or less expectoration.

The *symptoms* of the disease may be divided into such as precede or attend a paroxysm. Most writers agree in representing a disordered state of the stomach, or some of the collatitious viscera, as preliminary to an attack, expressed, usually,

by distension of the primæ viæ, from flatulence with sour eructations, gastrodynia, cardialgia, constipation, and tenderness of the abdomen, painfully felt on going to stool. But, though general, this state does not, at least in any very conspicuous degree, universally prevail. Cases I have seen, where there was an entire exemption from it, or so faintly presented, as scarcely to attract attention. As precursory of an attack, however, there may be nearly always remarked, uneasiness of the head and of the eyes, drowsiness, lassitude, fulness of the stomach and bowels, borborygmus, and discharges of wind, with heaviness of breathing, stricture of the chest, præcordial anxiety, depression of spirits or irrascibility of temper, and a general feeling of uncomfortableness, all which, are more sensibly experienced in the evening.

In this state, the patient may go to bed, with the anticipation of an attack, which shall come on while still awake—or he falls asleep, out of which he is aroused at once, or for a few minutes seems to be bewildered by a sort of incubus, half conscious of his situation, though unable to command self-possession. The paroxysm is mostly announced with an increased sense of thoracic tightness and oppression, without any acute or positive pain, soon followed by difficult, laborious, and wheezing respiration, in which the muscles subservient to that process appear to be implicated, attended usually at first by a dry spasmodic cough, though ultimately by copious secretions of phlegm or mucus, resembling the sputa in bronchitis. The distress is aggravated by motion, and so much by the recumbent posture, that in many cases, it cannot be endured at all, or only for a short period. The circulation is commonly little affected, sometimes preternaturally weak, the cutaneous surface cold, the countenance pallid and haggard: but in other, though comparatively rare instances, it is full, vigorous, and decidedly febrile—the skin warm, the face flushed and tumid, the eyes protuberant and injected, with dryness of the nostrils and fauces. This is the *asthma plethoricum* of some of the nosologists. The paroxysm being of extraordinary violence, from the obstruction of the bronchi or pulmonary circulation, the countenance has a purple hue—and such is the degree of anhelation, that, to prevent suffocation, the patient is propped up, and exposed to the fresh air, by the opening of doors and windows, he feeling, as it were, "as if the room were too small, and too confined, for his breathing."

An attack continues for several hours, or during the greater portion of the night, progressively mitigating towards morning. But, with this abatement, some unpleasant sensations of the head, chest, or primæ viæ, or all, still remain throughout the next day, and, on the approach of evening, or towards midnight, there is a repetition of the paroxysm. It is in this manner, that with alternate remissions and exacerbations, the case proceeds for a time, generally not more than three nights, till it is relieved by our remedies, or, as oftener happens, expends itself by some critical discharge, perspiration, urination, and especially by expectoration of digested mucus. The individual may then be restored to his natural health.

Death rarely occurs in the paroxysm, and when it does, we shall find immediately to precede it, a most distressing anhelation, frothing of the mouth, livid countenance, a weak tremulous pulse, or total failure of it, great depression of general strength, and sometimes, more or less paralysis of the upper extremities.

Becoming chronic, asthma may terminate in some disorganization of the lungs or heart, or great blood-vessels, or of the abdominal viscera, followed by dropsy of the cavities of the chest or abdomen, or by diabetes, and occasionally in lesions of the brain or nerves. But it also endures without such degenerations, and the person attains even to old age, with tolerable comfort,—while, in medium instances, where no essential structural injury exists, his health becomes greatly impaired, and he lingers out an existence of complicated wretchedness, till the disease undergoes a fatal exasperation, or he is otherwise released by death.

In the recurrence of asthma, there is much difference, though generally, it does not observe very strictly the law of periodical movement. Examples are recorded of its renewal on an average weekly, monthly, annually, or even at a more distant period, once or twice, for instance, in the course of a long life. But sometimes it is more exact in its repetitions. Thus, HEBERDEN relates a case of the return of the paroxysm every seven years for six successive periods, and several are reported of a monthly reversion, with perfect precision. This is what I consider to be genuine asthma contradistinguished from other forms of anhelation, of a more continued character, hitherto very impro-

perly confounded with it. That the disease may in time lose its peculiar feature of periodicity is undoubtedly true. But then it parts with its primitive identity and assumes a new shape, dependent on causes entirely different, disorganizations of structure in the lungs or remoter parts, which impede respiration, and otherwise imitate asthma.

In reviewing the *etiology* of asthma, it will not be easy to separate the remote from the exciting causes, with distinctness or propriety. The predisposition to it has been supposed to be intimately connected with a peculiar conformation of structure, consisting mainly in a narrow ill-shaped chest, or contracted larynx, trachea, or bronchi, with a temperament of extreme sensibility. But I have seen the disease so frequently without any such peculiarities, that I do not think they can exercise any considerable influence in its production. As to temperament, especially, I am persuaded it is as often incident to the phlegmatic, and perhaps the sanguine, as to the nervous.

That asthma is hereditary, cannot be doubted, and even to some extent, descending from generation to generation, and pervading a family of children—of which, examples have come under my own observation. On what the transmission depends, is not at all intelligible—most probably, however, on a constitutional similarity, though this is sometimes so little apparent, that it must be rather assumed than demonstrated.

Not much can be ascribed to age or sex in the development of susceptibility to the disease. Contrary to the prevalent opinion, that it mostly occurs in the middle of life, I have certainly met with an equal number of instances in children, or prior to the season of puberty, and scarcely fewer among old persons. Nor have I discovered any marked difference in this respect, between males and females, and cannot help suspecting the accuracy of estimates leading to an opposite conclusion, particularly that of Frank, of Vienna, which makes the liability of the former as six to one. Not unlikely this error has proceeded from a loose generalization of affections which, however analogous in some of their features, were still not of a real asthmatic nature.

From a deficiency of authentic information, it is not easy to appreciate justly, the influence of station, habits, and occupations, in this case. But according to my own experience, the sedentary, indolent and luxurious of the higher orders of society, are infinitely more disposed to the disease, than the reverse, or the low, the active, or labouring classes. It is, indeed, seldom to be met with in such, unless engaged in operations in which some acrid effluvia escape, irritating the respiratory apparatus.

Nearly an equal degree of uncertainty prevails as to the tendencies of climate. The common notion, however, is, that the disease is of less frequent occurrence in the mild and equable than in the variable, or in either extreme of latitude, the hyperborean or torrid regions, and which is not improbable,—though I confess that I have not remarked any material difference in the effect of our so diversified seasons. Every condition of weather occasions it, the hot and the cold, the wet and dry, or a dense or rarefied atmosphere —and such is its capriciousness, that what proves favourable to one individual, is as adverse to others. But independently of the sensible states of the air, there would seem to be some occult quality belonging to it, that is more decidedly operative on the asthmatic constitution. The pure air of the country, especially in elevated positions, I have found, with very few exceptions, more pernicious than that of cities, and even the suburbs of these less propitious than the central and populous parts. Many instances have come under my own view, of persons affected in this way, who, very comfortable in the latter, were rendered otherwise in the former situation, among which, is that of a friend of mine, who can seldom walk to the edge of the city with impunity, and never goes into the country without an attack.

Moreover, positions nearly contiguous in the heart of a city, may vary widely in this respect, or even the several stories of the same house. Each of these statements, at least, is verified by one case which was the subject of my care. Called to visit a young lady from the South, having a violent paroxysm of the disease, I was told that she derived an immunity from it during a recent residence in Paris, by selecting a medium story in a hotel in a particular portion of that city, and that whenever she quitted the apartment, a paroxysm soon came on, from which she was as speedily relieved by returning to it. Curious to make the experiment, I was seconded in the desire, by her own anxiety to change her lodgings, where she had severely suffered, and in a very short time she went to another house in the neighbourhood, in which she entirely escaped for several months. Compelled,

however, to leave it, she fixed her abode at the distance of a few hundred yards, in a street no less thickly built, and here she had scarcely any exemption for weeks. On her moving into a different quarter of the city, I witnessed a complete verification of the statement she had made me. As long as she occupied the chamber on the second floor, she was almost nightly harassed by renewals of attacks, which were prevented by her sleeping in the room above. Even by dining below, her respiration was on several occasions seriously affected.

Among the causes obviously exciting the disease, may be enumerated, the inhalation of the fumes from lead, or arsenic, or mercury, or other minerals, or the smoke of tobacco, or the dust of the same article, or the pungent or fetid odours or luscious perfumes, emitted by a great number of flowers or substances, as the rose, the hyacinth, fresh hay, red beets, mellow apples, sealing-wax, musk, and particularly ipecacuanha. Examples of attacks to be traced to each of these sources are reported, and as regards several of them, my own experience has supplied me with further proofs.

In an individual whom I attended, the disease was twice brought on by sleeping in a room where a rose-bush in bloom was placed—in another, by a similar exposure to some pots of hyacinths—in three girls, by the emanations in the process of manufacturing cigars—and there was formerly a student of medicine in the University of Pennsylvania, who assured me that he could not weigh out a dose of ipecacuanha without being affected. Certain irrespirable gases, as carbonic acid, escaping from the chimney of a dormitory, is said to have had the same effect, under like circumstances.

Most or perhaps all of the preceding causes operate directly on the pulmonary organs, to which are to be added, such as affect them secondarily or by irritations transmitted from other parts of the system. Thus it has been known to proceed from worms or offensive ingesta, even in moderate quantity, or excess in eating or drinking, or inanition from long fasting and constipation of the bowels. Derivative impressions, indeed, from the whole of the abdominal viscera, and above all, the uterus, as manifestly induce it, and we shall presently see that still more is imputed to lesions of the thoracic contents.

It were well, had a closer attention been directed to the influence of spinal irritations in the production of the disease. Cases having unequivocally a location in the upper portion of the vertebral column, I have so repeatedly seen, that I am persuaded of its being a more common origin of it than heretofore suspected.

Entertaining the notion of the frequency of the disease from the repercussion of eruptions, *asthma exanthematicum* has been erected into a distinct species in some of the nosological arrangements. But in consequence of the permanent character of the affection, when in this mode induced, it seems to me doubtful, whether it should not be considered rather as dyspnœa, which, in the present acceptation of the term, is continued oppression, and not intermittent or paroxysmal, than genuine asthma. Nevertheless, though they may not come within the definition I have given of the disease, I cannot withhold the communication of some very interesting instances of the kind, I have met with.

The first of these, was that of a gentleman who having repelled a wide-spread tetter from the inside of the thigh, was soon after seized with the most afflicting anhelation, which continued with little remission, for nearly a year, resisting every variety of treatment, till the reappearance of the tetter, when relief was procured.

Even more extraordinary, was that of a man, who having the same sort of eruption on the scrotum, succeeded, as he supposed, in curing it. But almost immediately afterwards, he began to sneeze with scarcely any interruption by day or by night for several months. The irritation, however, being transferred from the nasal to the pulmonary tissue, was followed by an exchange of sneezing for a very oppressed state of the lungs, which for a length of time proved intractable to all remedies. Two days after consulting me, and before the treatment suggested could have had any effect, the tetter, spontaneously, as it were, replaced itself in its original position, and his health was restored.

Nearly about the same period, I had under my care a lady, for a scaly eruption on the back of the neck, extending into the hairy scalp, by which she was much annoyed. It had long existed, occasionally receding and again recurring. By a mild application, it speedily disappeared, and in the course of a few months showed itself on the forearm, gradually assuming a more scaly character. In this state, she left the city, and, as she presumed, was

cured of it by another physician. But from that moment, heavy dyspnœa supervened, which shortly proved fatal.

Nor are we without proof of similar consequences from the suppression of natural or habitual discharges, sometimes proceeding from amenorrhœa, or a stoppage of hemorrhoids—and ANDRAL has supplied us with a case ascribed to the healing of an old ulcer of the leg. It may also be owing to a metastasis of some other diseases, as rheumatism or gout especially. The late Professor BARTON, who was a victim to the irregular states of the latter disease, I have seen to suffer extremely from asthma, thus occasioned—and still more frequently, a friend, whom I have attended in more than one hundred similar attacks in the last twenty-five years. Coming on in him almost invariably in this way, gout will so continue for a few days, when usually fixing itself on some joint, the whole of the thoracic distress immediately ceases.

Besides this series of physical agencies, it is perfectly ascertained that the disease may be excited by certain moral emotions, as, the exasperation of rage, the agitation of fright, the impulse of joy, the depression of grief, &c., where there is extreme affectability in this respect. But in thus spreading out its etiology, I am very far from being satisfied, that in all instances, I have practised a just discrimination in the selection of the causes of asthma. Confiding too much in authority, as well as from inherent deficiencies, I do indeed apprehend, that I may have sometimes fallen into the common error of confounding very different affections with it, and particularly bronchitis, and other modifications of dyspnœa.

Diagnosis. As I have described it, asthma can scarcely be confounded with any other disease. The suddenness of its paroxysms, their entire subsidence, and periodical recurrence, with the severity and peculiar nature of the breathing, sufficiently distinguish it for the most part. The cases which bear the nearest resemblance to it, are bronchitis, pulmonary œdema, hydrothorax, some of the affections of the heart, as angina pectoris, and certain dyspeptic states. To discriminate it from these, where a comparison of symptoms fails, an appeal may be made to external exploration, though not much is positively gained by either percussion or auscultation, in pure uncomplicated asthma. But the utility of these means consists in the detection of other analogous affections having more definite signs, and thus, while showing that the case is not asthma, its real nature may be revealed.

Prognosis. Contracted early in life, in well-constituted individuals, or where excited by trivial or transient causes, it is generally a curable disease. As to the former, even if our remedies do not eradicate it, time, and the changes of puberty, will be apt to effect it. But occurring in more advanced age, or with a contracted ill-formed chest, or as an inheritance, or continuing till organic lesions take place, we shall rarely be warranted in pronouncing a favourable decision. It is here "*morbus maxime terribilis*," as it was originally called by WILLIS.

Post-mortem appearances. Dissection has disclosed very different phenomenon in asthma. The fact is, till recently, we had no precise view of the disease, and hence most of the reports of the anatomical characters are little to be trusted—these belonging, in many instances, to organic lesions of parts, of which the respiratory affection was merely an incident or perhaps wholly independent of them.

No trace of a morbid process can sometimes be discerned, in the lungs, or elsewhere. This had long been affirmed, and is now established by the concurrent testimony of CORVISART, LAENNEC, ANDRAL, BOUILLAUD, CRUVEILHIER, LEROUX, FERRUS, &c. Death here, is probably occasioned by spasm. But generally, there is phlogosis of the mucous lining of the lungs, diffused or in patches, or merely punctated, attended most frequently by exuberant secretions. There are instances, however, of a great deficiency in this latter respect, and then tumidity of the tissue exists. Nor would it seem, that either their substance, or pleural coverings, always escape congestion or inflammation—and occasionally œdema or emphysema of the cellular texture, together with a change of colour or softening of the brain, or effusions into it, have been remarked. Cases, however, are reported, in which the only appreciable lesion was of the nerves—in one of these, at the origin of the pneumogastric, the precise nature of which is not mentioned,—in a second, an ulcerous condition of it,—in a third, a small tumour along its course,—and in a fourth, an osseous deposition in the centre of the pulmonary plexus.

But in protracted and long-continued asthma, as might be expected, from the complications and degenerations to which it is liable, every species of disorganization has been met with, as well of the

thoracic as abdominal viscera especially, and which is shown to be the tenor of appearances from the time of MORGAGNI, BONETUS, and LIEUTAUD, down to that of BAILLIE, and ROSTAN, and other very recent cultivators of morbid anatomy.

Pathology. Notwithstanding these necroscopic reports, very little seems to be distinctly understood as to the pathology of asthma. It were a very unprofitable task to offer a retrospect of the idle conjectures or crude speculations of early times, in relation to the subject, and I shall hence decline it. CULLEN, and most of the more modern writers, suppose that the disease consists in a spasmodic constriction of the muscular fibres of the bronchi, which interrupts or disturbs respiration, and as a consequence, creates all the rest of the distressing symptoms. These fibres not having been shown, it was deemed at the time, a fatal objection to the hypothesis. But since the satisfactory investigations of SOEMMERING, CRUVEILHIER, and especially REISSEISSEN, who have demonstrated their existence both transversely and longitudinally as regards these tubes, it can no longer be alleged. BREE, however, contends, with some ingenuity, that in the leading, and most common form of the disease, the immediate cause is irritation in the air cells of the lungs, occasioned either by aerial acrimony or effusions of serum, here plainly mistaking the effect for the cause, at least in one of these cases. Every practitioner must have observed, that in what is called spasmodic asthma, particularly, the dyspnœa occurs long before the increased secretion of the mucous surface.

Denying that spasmodic asthma is a disease of the lungs, it is conjectured by WILSON PHILLIP, that its seat is in the upper part of the windpipe, which becomes contracted by spasm of its muscles, so as to prevent the ingress of air, and brings on the violent struggles for breath, characteristic of the paroxysms. Cases answering to this description, I have seen, though the affection of the larynx has appeared to me merely additional to the more general one of the bronchi, and at all events, from their rarity, ought to be held as anomalous occurrences.

The phenomena of the disease have been ascribed, by PARRY, to vascular engorgement of the mucous lining of the bronchi, productive of such a degree of tumidity of it, as mechanically to intercept the entrance of the air into the lungs. This may be sometimes the fact, though I suspect such a condition is always secondary, and consequential on antecedent spasmodic irritation.

By his autopsic inquiries, M. ROSTAN has been led to the inference, that the disease, never nervous or spasmodic, depends on an organic lesion of the lungs, heart, or large vessels. But such a notion, however correct as to some varieties of dyspnœa, cannot be sustained in its application to genuine asthma. This, as we have seen, not unfrequently makes its invasions suddenly, and disappears, leaving for an indefinite period an uninterrupted state of health—is re-excited by slight circumstances, and relieved by remedies which can have no control over the organic lesions alleged, which indeed, have been proved, sometimes, not to have existed. Most of the speculations on this point are marked by extreme vagueness. Dyspnœa, however induced, or whatever might be its particular nature, having long received the title of asthma, the most discrepant affections were held to be identical, and described accordingly. By the same want of discrimination, I apprehend, the writer just cited has been seduced into the adoption of such an erroneous hypothesis.

It appears to me highly probable, that asthma is essentially an affection of the bronchial structure, in the shape of spasm. The phlogosis, effusions, and other morbid phenomena occasionally observable, are, according to this view, to be considered merely as results of this pre-existing spasm. Careful observation, however, will lead us to consider some of the spasmodic movements, hitherto referred to the bronchi themselves, as actually existing in the upper portion of the trachea, or in the diaphragm, intercostal and other muscles subservient to the respiratory function. As the muscular apparatus in vomiting is excited, when the stomach is offended, so is that of the pulmonary organs, to discharge or overcome irritations in the lungs, and may, in their efforts to this end, become irregular and disorderly in their actions. Either spasm of the bronchi, or excessive secretions from their mucous surfaces, or both, are the direct causes of such endeavours in the asthmatic paroxysm. But on other occasions, it may be perceived, that the chief aim of the muscles of respiration, is to dilate the chest, so as to allow greater freedom to the admission of air, and in the performance of this office, are often more naturally exerted.

It is not unlikely, I think, as has been conjectured, that the immediate seat of the primary irritation, in many instances

of this disease, may be the pneumogastric nerves. Looking at their distribution, several of the most prominent of the affections of the case, become very explicable on such a supposition. Granting this, it is no less apparent to me, that it does also arise occasionally in any one section of the nervous system. That I have seen it proceeding from the spinal and ganglionic, I am as well assured as of any fact. Nor when we advert to the intimate connexion of the nerves from every source, is there any difficulty in the hypothesis. It may be deduced from all which has been said, that I consider asthma as originating in nervous irritation, soon productive of irregular spasmodic movements, often followed by inflammation of the pulmonary tissues and excessive secretions, which condition, not being arrested, it may lead to very serious and multiplied lesions of structure.

From the very indefinite notions of asthma, to which I have more than once alluded, as having prevailed, the disease has been separated into a great number of species or varieties. By Sauvages, eighteen are made, and he scarcely exceeds some other writers. But this surely is a minuteness of classification, not warrantable by the nature of the case, and is calculated rather to perplex, than to illustrate the management of the disease.

The ordinary division of asthma, and that usually adopted, is into spasmodic and humoral—the one being dry, and the other attended with profuse secretions, the first mostly incident to the early, and the second, to the advanced period of life. Even these two forms of the disease, though occasionally observable, have no specific character, and cannot claim to be nosologically distinguished. The difference between them seems to depend only, as in the instance of common catarrh, on a secreting or non-secretory state of the mucous surface of the lungs, each of which mostly takes place too, in the progressive stages of the same caso.

Treatment. Whatever pathological views may be entertained, the treatment arranges itself into such as is proper during the paroxysm, and in the interval, to retard or prevent its return, or in other words, to eradicate the disease. It is necessary to premise, that I shall apply my remarks only to its curable state. Disorganization having taken place, the case changes its character, and may be deemed hopeless, or demands another course for its relief.

Contemplating merely the prominent symptoms of such an attack as I have reference to, no practitioner would hesitate probably a moment, about the propriety of venesection. It seems to be called for, by the congestion of the lungs, by the laborious respiration, by the suffused countenance, sometimes by activity of the circulation, and by a variety of other considerations. Yet it is confessed, that the remedy is an ambiguous one, and while by many it is utterly condemned, even those who occasionally recur to it, allow, that the advantages derived, are not at all correspondent to what might be expected. My conviction, however, is, that though our anticipations from it may not be realized in the fullest extent, venesection in the more violent paroxysms is useful, and even indispensable. As a general rule, it should be restricted to the febrile cases, or where there is much general vascular disturbance, and here, it will be found, or I am greatly deceived, to abate the vehemence, as well as shorten the duration, of the paroxysm—and most indubitably, it obviates those injuries of the lungs and other structures, which lay the foundation of the chronic lesions of which I formerly spoke. Cases, however, occur, where venesection is inadmissible, though there may be present no inconsiderable pulmonary oppression. It is in this state, that topical depletion is indicated, and may be beneficially employed. As in nearly every other pectoral affection, however, the blood should be drawn from the back of the neck and between the shoulders. Taken from these parts, it is generally more effectual, and becomes indispensable, should there be irritation of the upper portion of the spine. The chief exception to this practice is to be found in the dependence of the case on a primary or predominant affection of the ganglionic nerves,—and here it answers better from the breast and epigastric region. Exactly the same precept is to be observed in the application of blisters, to the neglect of which, much of the contrariety of sentiment which prevails as to their utility, may be ascribed.

Greater unanimity perhaps exists in regard to emetics than any other remedy. Most of the older writers urge them strongly, and the same recommendation of them has been generally continued to the present times. But some are opposed to the practice, as hazardous or altogether inefficient—though for reasons so frivolous, that so far from being influenced by them, I habitually prescribe vomiting in the paroxysm, and very frequently with marked success, especially in children.

The nature of the case should not materially influence us. Whether to resolve spasm, or to remove vascular congestion, or to empty the bronchi of excessive secretions, or to act on the skin, it is equally serviceable. Confessedly of the highest utility in croup and bronchitis, why should it prove otherwise in a case so analogous to these affections? Generally, the ipecacuanha is here preferred, which I believe was originally proposed by Akenside, the physician and poet. The squill, however, has been greatly praised, and it is not at all unlikely, that it is well suited to the disease, and especially when it occurs in old people, whose lungs are mostly oppressed, and hence require to be emulged or unloaded, by an emetic active and stimulating. Much, too, has been said, of the increased value of the combination of the two articles. The sulphate of zinc, moreover, is not without its advocates, among whom was the late Professor Kuhn, who employed it in this, as well as in every other spasmodic affection of the lungs, or their appendages, from a conviction of its superior antispasmodic properties.

Emetics, in nauseating doses, are, by some, preferred to active vomiting, and the comparative utility of the two modes seems not to be satisfactorily determined. To me, however, it is clear, that the one or the other, in this, as in all other instances, is to be directed according to the stage and circumstances of the disease. To break down the attack, as it were, vomiting is infinitely more powerful, while in reference to the expectorant or diaphoretic effect, the nauseating doses answer better. Commonly, the ipecacuanha is given for this purpose. But in old people, the more stimulating expectorants will be demanded—the squill, the syrup of garlic, the assafetida, the gum ammoniac, the seneka, &c.

Many practitioners speak favourably of the tincture of the Lobelia inflata, and some extravagantly—with which I have no experience. But I think I have seen the juice or tincture of the berry of the Poke, *Phytolacea Decandria*, decidedly serviceable in one case, and I have heard much of its efficacy.

No great importance is attached to purgatives in the treatment of asthma. Being induced, however, by constipation, this condition, at least, should be removed. But there are other purposes to be met by purging. Certain it is, that I have derived advantage from the use of calomel, especially, as well as an evacuant of the bowels, as by the property it possesses of unloading oppressed lungs proceeding from undue accumulations of blood or viscid secretions, it being, in the latter view, a very efficient expectorant.

Nothing seems to be more reasonable, from the received notions of the nature of the asthmatic paroxysm, than that opiates should be of service in it, and they have accordingly been liberally prescribed. Bree, a writer on the disease, whom I formerly cited, says, however, that they are uniformly hurtful—and such is not a rare opinion. The truth is, that the effect of them varies at different stages of the paroxysm, they being always misapplied, I suspect, in the height of it. But it being in part subdued by the preceding active means, opiates, then, are very serviceable, and especially when combined with a diaphoretic, as in the Dover's powder. The state of the skin has, indeed, I suspect, been not sufficiently regarded in the treatment of asthma. But when we advert to its influence over the lungs in health and disease, it becomes obvious how important it must be to revive or promote its action. On the breaking out of perspiration, warm and diffused, I have usually found a very decided alleviation to accrue.

Not content with opiates alone, every article allied to this class, including the narcotics and antispasmodics, cicuta, hyoscyamus, belladonna, musk, assafetida, ether, &c., has been successively tried, singly, and variously combined. What I have said in relation to opiates, is equally applicable to their congenera, with this difference only, that I believe the whole of them are of inferior pretensions. The best opiate merely to calm irritation, is the elixir paregoric, and especially when the disease occurs in aged people, to whom it is peculiarly well suited, in this and every other pectoral affection. Yet disagreeing with the patient, the pure opium, or some other of its preparations, may be tried, as well as the kindred articles mentioned.

During the paroxysm, an alleviation is sometimes procured by drinking intensely cold water—and, in other instances, by sipping hot water, or other hot beverages, such as very strong coffee, without cream or sugar. Exposure to cold air is also beneficial, though sitting near a fire, with the feet applied to it, still more frequently is found effectual. Large doses of the fixed alkalies have been recommended, and there is much evidence to the efficacy of vinegar freely given. Let there be no

surprise at my mentioning such opposite remedies! This is not the only disease, where means, diametrically the reverse of each other, are found serviceable, and which we employ without the usual guide or reason. It may be humiliating to the pride of science, though it is indisputably true, that often in practice, we are compelled to throw all our boasted principles behind our backs, and trust alone to the lessons of experience, in the spirit of empiricism.

To relieve the lungs when oppressed by inordinate secretions, inhalations of vapour are obviously pointed out, and have been recurred to in many instances, with success. Even the steam of water is not without utility, though it may be improved by those medications to be detailed under the head of *Bronchitis.* The vapour of iodine and of chlorine has also been lately proposed.

It was at one period in the reign of pneumatic medicine, very much the fashion to use, with this design, the factitious airs. Consulting the reports of Beddoes, Thornton, and others, on the subject, it will be perceived, that these gases are most enthusiastically praised. By one of them it is affirmed, "that the effect of oxygen is altogether miraculous—the moment it is inspired, the livid colour of the countenance disappears, laborious respiration ceases, and the functions of all the thoracic organs go on easily and pleasantly." But subsequent and more faithful trials have proved that no such benefit accrues, either from oxygen, or any one of the irrespirable gases, alone, or united with atmospheric air; and this suggestion, like many other similar extravagances which have had an ephemeral existence, is dead, and gone to the "tomb of all the Capulets."

The insufflation of the atmospheric air, is perhaps more entitled to attention. By Chiarenti, an Italian writer, we are at least told that he himself is uniformly relieved almost instantly by it, and that it has proved equally successful in other persons by whom it has been tried. The pipe of a common bellows is to be introduced into the mouth, the nostrils closed by compression of the fingers, and the air to be forcibly pushed into the lungs. (*Anthologia di Firenze*, Sept. 1835; and *Philada. Journ. Med. and Phys. Sc.* XIV. 374.)

Being, in some degree, a modification of the practice of inhalation, the smoking of certain substances, and partially breathing the fumes, may be here noticed. My allusion is more particularly to the stramonium, which has attracted a great deal of notoriety as a palliative of the paroxysm. It is used in a common pipe—the root of the plant selected for the purpose, being previously washed, dried, and bruised. That it affords relief, occasionally, I cannot doubt, independently of other evidence of it, having witnessed it, in several cases. Like other remedies, however, it will often fail, and, perhaps, only does good in certain forms of the disease, which hitherto have not been accurately designated. The cigar, also, proves sometimes palliative, and especially in persons not habituated to the practice of smoking. Never have I witnessed any injury from either article, in this application of them, and am incredulous of the statements of the European writers by whom their use is so seriously deprecated.

Magnetism, electricity, and galvanism, have been adopted as remedies—and the reports regarding the last, are very curious, proving, that through the galvanic agency, the paroxysm is promptly mitigated, or removed, and by perseverance in its use, permanent cures are often accomplished. Not a little is affirmed of its efficacy by Mons. Andrieux, in a recent memoir on the subject, who has pursued the practice to a great extent,—and his statements are amply confirmed. By M. Martin it is said, that he has had frequent opportunities of observing the extraordinary success of it, as conducted by Andrieux in the Hôtel-Dieu, having even "known patients in whom the paroxysms were so severe and frequent as to render it impossible for them to engage in any occupation, entirely restored to health by it, in the course of a few weeks." He on the whole assigns to it the highest rank among the means employed in the disease. (Martinet's *Practice.* p. 110.) The celebrated Wilson Philip also bears testimony in its favour, and many other attestations of the same kind might be cited. Conceding the fact of its utility, which can hardly be controverted, we must be irresistibly drawn to the conclusion, that asthma, as has been contended, is really little more than a mere nervous or spasmodic affection.

We now come to the second indication, or to the treatment in the interval of the paroxysms, with a view to the eradication of the disease. To be at all successful, it must be accommodated to the several conditions in which the system may be left. These are exceedingly diversified, and being, for the most part, connected with some positive lesion, considered as a dis-

tinct affection, to be hereafter fully discussed, I shall, at present, give to the subject a very cursory notice.

Mostly, the alimentary canal is disordered, and when so, the management, in every respect, is the same as in dyspepsia. The remedies in the latter case will, under similar circumstances, be found equally appropriate to asthma, and above all, the martial preparations. They have been greatly extolled by Bree, and independently of their general power and effects, would seem to have further claims in this instance, from their reputation in those nervous affections to which asthma sometimes bears a resemblance.

In cases observant, with some exactness, of the law of periodicity, other tonics are resorted to, among which are the sulphate of quinine, the arsenical solution, the oxide and sulphate of zinc, the sulphate of copper, and the nitrate of silver.

Characterized by a disposition to spasm, the state is managed by the valerian, myrrh, musk, castor, assafetida, the oil of amber, ether, &c.—and when nervous irritability preponderates, by opiates, henbane, hemlock, belladonna, stramonium, and the prussic acid. Being assimilated to chronic bronchitis, the balsamic and terrebinthinates, especially the tar pill, is greatly relied on, and which I deem eminently useful. Lastly, on an apprehension of effusions, mild purging, and the diuretics, constitute the proper means.

It need scarcely be remarked, that if the case can be distinctly traced to a special cause, as, obstruction of the catamenia, the suppression of hemorrhoids, the recession of eruptions, or to misplaced gout, or spinal or similar irritations, our efforts should be directed to its removal as speedily as possible, the best means of doing which, will be elsewhere pointed out. (See the articles on these affections.)

Little else remains, than to indicate the proper regimen, to which, in my opinion, more consequence should be attached, than to the therapeutic treatment.

As gastric irritation operates as an exciting or aggravating cause of asthma, it is obvious that the diet must be strictly regarded. Even where no dyspeptic symptoms exist, some restrictions are demanded in the course of living. No trespass, either in eating or drinking, is ever to be permitted, and constipation should be avoided. No less important is it to guard against the austere vicissitudes of weather, by warm clothing, and especially by wearing flannel next to the skin, protecting the feet, at the same time, in the most effectual manner.

Exercise, and even labour, are very beneficial. Long journeys have frequently removed the disease—and contrary to what we might expect, the same effect has been obtained by the exposure and hardships of military life. During the late war, when the volunteers of Philadelphia were called out, and encamped for several months, part of the time in winter, two individuals of my acquaintance, who, previously, had been dreadfully harassed by the disease, entirely escaped while thus employed, and have since been nearly exempt from it. Many similar facts are recorded.

The disease becoming habitual, a trial of a change of residence should be proposed. As, perhaps, in every other pulmonary affection, a mild and equable climate is generally to be preferred. But the precise situation is to be very much determined by the experience of the individual himself, though, as already intimated, for the most part, a low is better than an elevated position, and a large city than a village or the country,

Concerning a vicinity to the sea-shore, there is equal uncertainty as to its influence. Commonly, I have found it salutary, while in some instances, it proved so prejudicial, as not at all to be endured. Cases will, indeed, occur, where, as soon as the individual breathes such an atmosphere, a paroxysm comes on. But, should an exposure of this sort agree with him, immense benefit will result from it and sea-bathing. Not, however, being convenient or admissible, the cold bath may be substituted, the efficacy of which is improved by the addition of salt, and subsequent frictions, so as to induce a general glow of the surface. The warm bath, which has been recommended by some writers, I have found injurious.

On a review of what has been said of the treatment of this disease, it is impossible to resist the conclusion, that great as the recent efforts have been to reduce it to some definite principles, it is still amenable to the charge of empiricism. As must always happen, this is owing to the want of a correct pathology. It may be true, that our notions regarding it are not so absurd as those of former times, when necroscopic investigations were less practised. To the attainment, however, of correct and useful views on the subject, such as shall serve to conduct us to successful practice, much remains to be ac-

complished. As it is, at present, we can really claim very little certainty in the management of any stage or condition of the disease. The remedies which control one case, utterly fail in another, of apparent identity, and hence the number of expe ents, and diversities of plans, that have and continue to be adopted for the relief of the disease.

Considering how limited and precarious are our powers in this respect, it becomes a duty to enjoin our patients to be vigilant of the approach of an attack, and the moment we are apprised of it, to endeavour to arrest its further progress, which, comparatively, is easily done. Coming on as catarrh, it is in this inchoative stage to be treated accordingly. Being mild, a stimulating pediluvium, with an opiate diaphoretic, and some warm beverage, will generally be sufficient, provided perspiration is excited. But when the indications are more menacing, the loss of blood, with sinapisms to the lower extremities, are required. These failing, an emetic of ipecacuanha should be directed, and after puking, the Dover's powder, with the usual promotives of its operation.

By such a course, I have in many instances, averted attacks, and had the gratification of preventing an intensity of suffering which can only be appreciated by those who have witnessed the effects of a severe paroxysm of the disease.

N. CHAPMAN.

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See the Bibliography of the next article, and of the articles *Dyspnœa*, *Bronchitis*, emphysema of the *Lungs*, diseases of the *Heart*; also the general Treatises on Diseases, and particularly the works of KREYSSIG, JOS. FRANK (*Prax. Med. Præcept.*), NAUMANN (*Handb. der Med. Klinik*), and LAENNEC (*Traité d'aucult.*).

I. H.

ASTHMA OF MILLAR, or ACUTE ASTHMA. MILLAR gave the name of acute asthma, to a form of intermittent dyspnœa, considered by him as peculiar to children and common in them until the age of puberty. He describes it as attacking suddenly, often at night, like croup, and as particularly distinguished by paroxysms of suffocation, accompanied by a kind of croaking analogous to that observed in some hysterical attacks. These characters, considered by MILLAR as diagnostic, also belong to croup and to several phlegmasiæ of the larynx and trachea; and the uncertainty in which this imperfect description leaves us as to the disease intended to be designated, is not relieved by the cases given in illustration, of which there are three, so incomplete are the details. This want of precision in the work of MILLAR has given rise to much discussion among subsequent writers, respecting the affection he had in view, and renders it impossible to solve with certainty the question.

UNDERWOOD, CULLEN, and the ALBERS (uncle and nephew), considered the acute asthma of MILLAR to be croup, an opinion in which RUSH at first participated, though he subsequently abandoned it. JURINE regarded it as suffocating catarrh; JOY (*Cyclop. of Pract. Med.*) as spasm of the glottis; JOLLY (*Dict. de Méd. et de Chirurg. Prat.* III. 611.) as nervous or convulsive asthma, and GUERSENT seems now also so to regard it (*Dict. de Méd.* 2d ed.), though formerly he confounded it with false croup.

It is an unquestionable fact that true nervous asthma is met with in children, and presenting precisely the same characters as in adults and old persons; and it seems not improbable that this is the disease intended to be described by MILLAR, though, as has already been remarked, there are no means of determining this with absolute certainty.

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I. H.

ASTOMIA. (From α priv. and στομα, a mouth.) Without a mouth. (See *Acephalus.*) I. H.

ASTRAGALUS. A very irregular-shaped bone, situated at the upper and middle part of the tarsus, where it is articulated with the tibia. (See *Foot*, and *Bones.*) I. H.

ASTRAGALUS. (*Mat. Med.* and *Bot.*) *Sex. Syst.* Diadelphia decandria. *Nat. Ord.* Leguminoseæ.

Gen. Ch. Cal. five-toothed. *Corol.* with

the keel obtuse. *Legume* two or half two-celled, lower suture inflexed. BECK.

This extensive genus, consisting of nearly 250 species, most of which are peculiar to Asia, is composed of suffruticose or herbaceous plants having pinnate leaves, furnished with stipules either distinct from or connected with the petiole, and, in one subdivision, the *Tragacanthi* with these petioles rigidly persistent, forming spines. The flowers are glomerate or spiked, and axillary or terminal.

Most of the spinous species furnish a peculiar exudation known under the name of *Gum tragacanth:* this is more especially the case with those found in warm climates, and it is highly probable that under the same circumstances the whole of them would afford similar products. This supposition is strengthened by a number of analogous instances in the vegetable kingdom,—thus, the *Liquidambar styraciflua* exudes large quantities of an odorous balsam, in Georgia and other southern states, whilst in New Jersey and Pennsylvania, it affords but a trifling quantity of this secretion; the same also is the case with the *Fraxinus*, which in Sicily and Calabria produces manna, but in the more northern parts of Europe is almost destitute of saccharine juice.

All these species of Astragali possess the same general appearance and characteristics, and form so natural a group that it is somewhat remarkable, that the proposal of MILLER to form them into a separate genus under the name of *Tragacantha* has not been generally adopted by botanists. They are, without exception, small shrubs, with very numerous branches, covered with imbricated scales and beset with long spines, these latter, as above mentioned, being the remains of the persistent petioles. So great is their analogy and resemblance to each other, that LINNÆUS considered them all as varieties of one species, to which he gave the name of *A. tragacantha.* The more recent researches of PALLAS, DE CANDOLLE, and LIEDEBOUR, however, have shown the error of this amalgamation, though it must be confessed that the differential characters they have assigned as a guide in the discrimination of these species, are exceedingly vague and indeterminate; many of them evidently arising rather from the effects of climate and situation than from any inherent difference in the plants. In fact, the confusion that exists in their synonomy is so great, that it has become almost impossible to ascertain what species really exist in nature and what are founded on mere varieties or the misconceptions of the describers.

Thus, the original *A. tragacantha* of LINNÆUS is the *A. massiliensis* LAMARCK, and the *A. massiliensis* of the former is the *A. aristatus* VILLARS, though perhaps not of SIEBER or SIBTHORP. The *A. tragacantha* HABLIZT is the *A. poterium* PALLAS, the *A. creticus* LAMARCK is the *A. echinoides* WILLDENOW, and the *A. gummifer* LABILLARDIERE is the *A. caucasicus* DE CANDOLLE, &c. Hence, it becomes extremely difficult to decide which plants furnish the gum tragacanth of commerce, though it has been clearly shown, that this article is only procured from the spinous species. The London and United States Pharmacopœias have in this respect followed OLIVIER (*Voyage dans l'Empire Ottoman*) in ascribing it to the *A. verus.* On the other hand, LABILLARDIERE states that it is procured from the *A. gummifer*, and SIEBER from the *A. aristatus*, &c. (See *Tragacanth.*)

Some of the species belonging to the other subdivisions of this genus have also been employed for medical purposes, particularly the *A. excapus*, a native of mountainous regions in Europe; the root of this plant was highly spoken of many years since, in secondary syphilis, as well as in rheumatism and gout, but more recent experience has shown that its efficacy in these complaints is very doubtful.

R. E. GRIFFITH.

ASTRINGENTS. (From *astringere*, to bind.) This term is applied to a class of medicines distinguished by the property of exciting contraction in the living tissues. That such a property is possessed by certain substances is obvious to the senses. When one of these substances is placed in contact with the skin, an observable shrinking of the part occurs, with a diminution of colour consequent upon the contraction of the capillaries. If taken into the mouth, it produces in the tongue, cheeks, and fauces, a sense of puckering or constriction, which is quite peculiar, and has been admitted among the simple sensations by the name of the astringent taste. Nor is the operation of astringents confined to parts with which they may be brought into visible contact. A similar contracting power is exercised by them, when swallowed, upon the alimentary mucous membrane, as is evinced by the feeling of tightness or constriction in the epigastrium, which is sometimes even painful, and by the disposition to costiveness, resulting probably from the closure of the exhalent and secretory orifices of the

blood-vessels. Their influence, indeed, is felt, to a certain extent, over the whole system. In the healthy state, this general influence is not manifested by any striking phenomena; but in certain cases of disease, as in those accompanied with morbidly increased discharges, it becomes very evident in the curative effects which result from it.

By some writers, the operation of astringent medicines is supposed to be exerted exclusively upon the muscular fibre. But there appears to be no sufficient ground for this limitation of their influence. It is now generally admitted that every vital portion of the animal system is endowed with the property of contractility, which requires only an appropriate stimulus to bring it into action. There is consequently nothing in the constitution of our frame which would necessarily restrict the astringent operation to the muscular fibre; and the notion is certainly not supported by observation; for, so far as our senses can discover, the contraction produced by the medicines under consideration, extends equally to all parts of every vital tissue with which they are brought into contact.

The circumstance that dead animal structure becomes firmer and denser under the action of certain astringents, formerly led to the opinion, that their effects on the living tissues might be of the same nature, and consequently ascribable to a chemical or mechanical agency. But it is now well understood, that the influence of these astringents upon dead animal matter is owing to a combination between the tannin of the former and one or more of the proximate constituents of the latter; and it is also well understood, that such a combination could not take place in the living body without producing fatal disorganization. We must, therefore, seek some other explanation of their operation; and none appears more satisfactory than that already referred to—that astringents offer the stimulus necessary to call into energetic action the organic contractility which essentially belongs to every vital tissue.

In what way astringents produce their peculiar effects upon the system at large, whether by the propagation of a sympathetic impression from the stomach over the whole frame, or by entering into the circulation and through the medium of the blood coming into absolute contact with every part to which this fluid is carried, is a question which has not yet been determinately settled. CULLEN supports the former opinion by the arguments, *first*, that astringents taken into the stomach operate upon other parts of the body so speedily as to render it improbable that they have passed out of this viscus, and *secondly*, that, if conveyed at all into the circulation, they are so in quantities so small as, when mingled with the mass of blood, to be incapable of producing any effect upon the parts with which they may come in contact. But neither of these arguments is conclusive. Since the time of CULLEN, it has been abundantly proved by experiment, that medicines are absorbed, enter the circulation, and pass out by the secretions, in the course of a few minutes; and there is reason to believe that substances, mingled with the blood, produce powerful impressions in quantities, which, if confined in their application to a surface communicating externally, would give rise to no sensible effect. It is reasonable to suppose, that if astringents operated upon the system by means of sympathy alone, their effects would be most strikingly evinced in those organs with which the sympathetic connexion of the stomach is most intimate. But this does not appear to be the case; and, as some of the substances belonging to the class have been detected in the blood or secretions after having been swallowed, it is a fair inference that they may act remedially through the medium of the circulation. It is not impossible, however, that they combine both modes of operating. In whatever mode their general operation is effected, it is much less observable than that which results from their local application; and some physicians have even doubted whether their influence really extends beyond the surface which first receives their impression. But when we consider the results which frequently follow their administration in diseases of parts which they can affect only through the system—results too frequent and uniform to proceed from accidental causes—there seems to be no room for hesitation in admitting their claim to the rank of general remedies; and the great majority of physicians at present not only believe in the extension of their astringent operation to various parts of the body, but habitually act upon that impression.

The astringent action is entirely distinct from that produced by any other class of remedies. It has been thought to bear some analogy to that of tonics; and there is one condition of system in which its effects may be considered as identical, to a certain extent, with those produced

by the medicines alluded to. Thus, when debility is connected with a relaxed condition of the tissues, astringents, by restoring their natural tension or solidity, act the part of tonics, and give increased vigour to the organ affected or to the system at large. But still, the tonic action, properly speaking, is essentially different from the astringent. By the former, all the natural powers of the system, or any of its parts to which the medicine may be directed, are invigorated; the healthy actions are exalted in degree without being changed in nature; and the results, when the application of the remedy is properly directed and kept within due bounds, are simply those of increased health and strength. By the latter, only one of the vital properties is essentially called into action—namely, that of organic contractility—and the effect is often to restrain or derange some of the healthy functions, as, for example, that of secretion. It is true, that the tonic power is very often associated with the astringent in the same medicine, either in consequence of the union of a bitter with the astringent principle, as in many vegetable products, or of such an internal constitution in the remedy as allows it to combine two distinct physiological properties in the same particles, as in several metallic preparations. But that they are not essentially associated is proved by the fact, that some medicines are powerfully astringent, which, so far from being tonic, are directly sedative in their influence upon the nervous, and in some measure probably also upon the circulatory, system. Such are the preparations of lead. These observations are not without an important practical bearing. As astringency is associated, in different medicines, with other properties which are of a diversified and even opposite nature, it is necessary, in the employment of these medicines, to extend our views beyond the property which characterizes them as a class, and to take care that there exist no incompatibility between them and the existing state of the system. Thus, it would be improper to employ a tonic astringent under circumstances which might justify or even demand the use of one of a sedative character. We may often advantageously give the acetate of lead in the early stage of hemorrhages, when the vegetable astringents might be deemed improper from the possession of a tonic or stimulant power.

Therapeutical application. The medicines belonging to this class are capable of fulfilling three distinct indications in the treatment of disease. They correct a morbid laxity of the tissues, by their general astringent influence; they suppress or restrain unhealthy discharges, by closing the vascular orifices through which the eliminated fluid passes; and they obviate inflammation in certain stages, and in certain positions, by diminishing the capacity of the blood-vessels, and thus lessening the quantity of blood in the part affected. A few general observations under these three heads will embrace all that it will be necessary to say at present in relation to the therapeutical employment of astringents. More precise rules for their practical application will be given in treating of the particular remedies which compose the class.

1. A general looseness of texture in the solids, marked by a softness or flabbiness to the touch, paleness, deficient muscular and vascular energy, and an almost universal feebleness in the performance of the vital functions, occurs as an accompaniment or consequence of various chronic complaints, particularly those of a scrofulous nature, which it tends to aggravate, and to render more obstinate. Here, astringent medicines united with tonics, or such as combine in themselves both astringent and tonic properties, will be found highly useful. They may be taken internally, and at the same time, especially in infantile cases, applied externally in the form of baths.

Diseases consisting in local relaxation call for the use of astringents upon the same principles; but in these it is requisite that the remedy should be applied as nearly as possible to the part affected. Instances of this kind we have in prolapsus of the uvula, anus, and uterus, not connected with inflammation of these parts, and in some forms of varicose veins.

2. The obvious applicability of astringents to the suppression of morbid discharges, has rendered their use in these affections almost universal. It is of little consequence whether the discharge consist of blood unaltered, or some increased secretion. In either case, the fluid escapes, as a general rule, through natural outlets, which, in the instance of the hemorrhages at least, must be much enlarged; and astringents, by narrowing or closing these outlets, afford apparently the readiest means of cure. But they cannot be used indiscriminately in all conditions and stages of these affections. It often happens that the discharge is consequent upon some irritation, congestion, or inflammation, perhaps of a dangerous char-

acter, existing in the part from which it proceeds, or in some other portion of the system. This morbid condition it may be calculated to relieve, and its untimely suppression may therefore lead to unpleasant consequences. This is particularly the case in the earlier stages of the disease. Under such circumstances, the use of astringents would either be attended with no effect in controlling the discharge, or would do injury by arresting it. The better plan is to address our remedies to the root of the disorder, and to endeavour to check the evacuation by removing its cause. Most of the astringents, moreover, possess excitant properties, which render them peculiarly inapplicable to the earlier stages of inflammatory affections. Occasionally, however, the evacuation, even when dependent on a local disease which it may be intended to relieve, is so profuse as to endanger serious if not fatal exhaustion, and therefore to constitute the chief point for the physician's attention. In this case, the use of astringents may be resorted to even at the risk of local injury. Again, it very frequently happens, that the evacuation continues after the irritation in which it originated has ceased, being kept up by the new habit which the vessels have acquired, or by a state of relaxation following the previous excitement. Here also, astringents are indicated, and often prove highly useful. Lastly, the discharge sometimes originates in a debilitated or relaxed condition of the vessels, which disables them from affording the due resistance to the circulating power; and the blood, or some one of its constituents but slightly modified, passes out almost mechanically through the open orifices. In these cases, astringents are the most effectual remedies, and may always be safely employed.

The operation of these medicines is most effectual when they can be applied directly to the part from which the discharge proceeds. Hence, their external use is generally followed by more striking results than their internal. Hemorrhage from the nostrils and rectum, excessive perspiration, and unhealthy secretions from the urethra, vagina, &c., are often immediately or very speedily arrested by the judicious employment of astringents directed immediately to the part affected. Of the diseases treated by their internal use, those which have their seat in the stomach and bowels are most sensibly benefited, for the very obvious reason, that the medicine is brought into immediate contact with the diseased surface, and thus superadds a direct impression to that which is felt by the alimentary canal, in common with all other parts of the body, from its general action upon the system. Hence the great importance of astringents in the treatment of those forms and states of diarrhœa which come within the rules already given for the employment of these medicines in the suppression of morbid discharges. In hæmatemesis and hemorrhage from the bowels they also prove highly beneficial; and they may sometimes be usefully employed in that relaxed condition of the bowels which occasionally supervenes upon an attack of dysentery, or attends that complaint in its chronic forms. But, though most obviously useful in external complaints, or those seated in the alimentary canal, they may often be used with great advantage in the hemorrhages and profluvia of other parts. Thus, astringents are habitually employed in hæmoptysis, menorrhagia or uterine hemorrhage, hæmaturia, profuse sweating, diabetes, and excessive secretion from the mucous membranes, particularly that of the bladder. It should always, however, be borne in mind that in these affections such measures as are calculated to relieve any existing local inflammation or general plethora, should precede the use of astringents, which, by their proper action, can answer no other purpose than merely to check the discharge.

3. It has been stated that these medicines sometimes prove useful in local inflammations, by diminishing the calibre of the capillaries, and thus partially expelling the blood from the seat of the disease. But it is clear that they can be useful in this way only when applied directly to the inflamed part. The contraction which results from their general influence upon the system is universal, and cannot therefore diminish the relative amount of blood in any one spot. Even in inflammatory affections to which they can be directly applied, they will not be found useful in all stages, and in all forms of application. On the contrary, when the disease is confirmed, or of an aggravated nature, so far from relieving, they will often increase it, especially when employed in a concentrated state. The irritation which most of them are capable of producing, more than counterbalances, under such circumstances, any good that can arise from their astringent action. The conditions of inflammation in which they are most useful are those which occur in its incipient and declining stages—particu-

larly the latter, when the calibre of the capillaries often remains unduly enlarged from the loss or diminution of their contractile power, and the signs of inflammation linger from this cause. The cases in which they are employed are those of inflammation of the conjunctiva, of the mucous membrane lining the mouth, throat, nostrils, urethra, vagina, and rectum, and of the skin. The mineral astringents are usually preferred, and of these the preparations of lead are, perhaps, the most efficient; as they combine a degree of sedative power with their astringency.

Division of Astringents. This class of medicines may very properly be arranged in two subdivisions—one including those of vegetable origin, the other those derived from the mineral kingdom.

The vegetable astringents are characterized by the presence, among their constituents, of a peculiar proximate principle, or perhaps set of principles, called tannin, in which their astringency chiefly resides. Tannin differs somewhat in chemical properties as found in different vegetables, but its effects upon the system are essentially the same in all its varieties. The medicines belonging to this subdivision may, therefore, be considered identical so far as regards the character of their astringent action. They differ from each other only in the properties derived from the other principles with which the tannin is associated. These are usually bitter or aromatic, and have the effect of rendering the astringent more tonic and stimulant than it would be without such combination. The chief difference, therefore, between the several vegetable astringents is in the degree of their tonic and excitant power, and reference should be had to this point in their application to the treatment of disease. The purest are the least stimulating, and should be preferred when the object is merely to obtain the astringent effect. But those in which the tannin is least mingled with other principles, are still somewhat excitant, and should not, as a general rule, be employed in states of considerable excitement. Gallic acid is also usually mentioned as an astringent principle. It is very often associated with tannin in vegetables, and, in addition to its sourness, has a slightly styptic taste; but the probability is that it scarcely modifies the properties of the particular substances in which it is found, and its presence or absence may be considered as an object of indifference in the choice of one of the vegetable astringents. The individuals belonging to this division of the class are very numerous; but as many of them are nearly identical in properties, comparatively few are at present employed. Those most in use in this country are, oak bark, galls, kino, catechu, rhatany, logwood, and the roots of the Rubus villosus and trivialis, and of the Geranium maculatum. Bistort, tormentil, red roses, and the rind of the pomegranate, are considerably used in Europe. A vast number of vegetable products unite astringency with other properties which it tends somewhat to modify, though it is not that for which they are chiefly used. Such are, uva ursi, pipsissewa, tea, coffee, rhubarb, sage, cinnamon, and most of the tonic barks, besides many other substances which it would be useless to enumerate.

The *mineral astringents* have nothing in common but their astringency. Each of them is characterized by properties peculiar to itself, and is consequently susceptible of a peculiar practical application. Thus, in addition to the properties which characterize them as a class, the salts of iron are tonic and emmenagogue, those of lead are sedative, sulphate of zinc is tonic in small doses and emetic in larger, sulphate of copper is tonic in small doses, emetic in large, and escharotic in its local action; and thus throughout the whole catalogue. It is obvious, therefore, that no other remarks are applicable to this division of astringents, either in relation to their properties or employment, than such as have already been made under the general head. The practitioner, in selecting any one of them to meet the indications for the use of astringent remedies, will be governed by the peculiar adaptation of its properties to the existing state of the system, or to some peculiarity in the disease. The most prominent mineral astringents are the acetates of lead, the sulphate and acetate of zinc, the sulphate of copper, the soluble salts of iron, alum, sulphuric acid, and lime and its carbonate.

GEO. B. WOOD.

ATAXIA. (From α priv. and τάξις, order.) Disorder, irregularity, malignity. This term, if employed in accordance with its etymology, would signify every disorder, every morbid condition; for when an organ is diseased, its actions and functions become disordered, irregular, and perverted; and it is in this extensive signification that it was used by HIPPOCRATES. Subsequent writers have, however, employed it in a more restricted sense. GALEN applied it more especially to irregularity of the pulse; SYDENHAM to dis-

order of the nerves. *Ataxia spirituum*, irregularity of the animal spirits, is, according to this last author, the source of hysteria and hypochondriasis. By modern writers, it is employed to designate a group of phenomena remarkable for the gravity of the organic affections with which they are connected and for the irregularity of the course of these diseases. These phenomena consist in weakness, perversion, or abolition of the functions of the organs of the senses; complete and sudden alteration of the countenance; extreme and convulsive movements or paralytic immobility of the muscles of the eyes and face; weakness of muscular power, so that the patient is obliged to remain in bed, at the same time that he is affected with partial spasms, cramps, subsultus tendinum, carphology, or rather great muscular agitation, a general spasmodic state, tetanic rigidity, epileptic paroxysms, and sometimes instantaneous increase of muscular strength, followed by its sudden loss; alteration of the voice, aphonia; paralysis of the bladder, of the pharynx, of the œsophagus, and of the sphincters of the rectum; obstinate insomnia or sleep disturbed by frightful dreams, starting out of sleep, nightmare, agitation of mind; somnolence, stupor or furious delirium; epileptic, cataleptic, apoplectic, or hydrophobic state, syncope, &c. (Georget, in *Dict. de Méd.* 2d ed. IV. 295.) If these disorders be traced to their source, they will be found to arise from an affection of the central nervous mass; ataxia is therefore dependent upon some grave lesion of the brain. But as the term has no reference to this condition, but is attached to uncertain and irregular groups of symptoms many of them the result of secondary affections, its signification is too vague to be retained in scientific nomenclature, and it should be stricken out of the medical vocabulary. (See *Encephalitis*, *Fever*, *Meningitis*.) I. H.

ATAXIC. *Atactus.* Appertaining to the state of *ataxia.* Selle and Penel applied this term to a class of fevers (*Fièvres ataxiques*), which comprise the affections known by the epithets of *malignant*, *putrid*, *nervous*, *cerebral*, *pernicious*, *typhoid*, fevers. (See *Fevers.*) I. H.

ATHEROMA. (From αθηξα, pulp.) αθηξωμα, *Atheroma.* An indolent encisted tumour containing a thick whitish matter resembling pap or *bouillie.* (See *Wen*, and *Tumours.*) I. H.

ATHEROMATOUS. Of the nature of atheroma. I. H.

ATLAS. The first vertebra of the neck. (See *Vertebræ*, and *Bones.*) I. H.

ATMIATRIA. (From ατμος, vapour, gas, and ιατξεια, treatment.) Treatment of diseases by gases or vapours, a term recently devised by Martin Solon. I. H.

ATMOSPHERE. Art. I. *Physical and Chemical History.* The mass of air by which the earth is surrounded, and which extends to a considerable but unknown height above its surface, is termed the atmosphere. It is the element in which we live, and exerts, both by its mechanical and chemical properties, a most important influence on the animal economy. We shall consider these properties briefly, in the present article.

The atmospheric air is a permanently elastic fluid. In what is usually assumed as its standard condition, (that is, when its temperature is 32°, and its elasticity is capable of supporting a mercurial column of 30 inches,) it is 770 times lighter than water, — a cubic foot of air weighing 567.89 grains.

The air is highly compressible and elastic, and experiment has proved that its elasticity is directly proportional to its density: so that if, at its ordinary density, it can support 30 in. of mercury, at double that density it will support 60 in., at half that density 15 in., &c. It is this property which is called the Law of Mariotte.

As the air has weight, the atmosphere must exert a pressure upon any surface on which it rests. The amount of this pressure is readily determined from the corresponding height of the barometer, and, when this height is 30 in., is equal to nearly 15 lbs. on every square inch, or to almost a ton on every square foot. Now the surface of the human body is estimated at from 12 to 15 feet: we may judge then of the enormous pressure which is constantly exerted upon it, and we may well inquire how it is that we are enabled to bear so great a burden. The paradox is, however, easily resolved; for it is evident that the pressure of the air in any one direction must be exactly counterbalanced by an equal pressure in the opposite direction. Thus the force acting upon the right side of the body, and which would impel it toward the left, is opposed and brought into equilibrium by an equal force acting on the left side of the body, and which would impel it toward the right. As to the tendency which the pressure of the atmosphere exerts to crush the body together, this is prevented

by the elasticity of the solids, liquids, and gases, that enter into its composition, and which need only be equal to that of the surrounding air, in order that the pressure of this fluid may be wholly insensible to us.

The weight of the atmosphere, as indicated by the barometer, is, even in the same situation, continually varying, though generally within narrow limits. At the level of the ocean, the mean height of the barometer is very nearly 30 in.; but it oscillates, in different conditions of the atmosphere, from 28 in. to 31,—the pressure upon the human body varying, of course, in the same proportion.

The compression of the air, in any place, is entirely due to the weight of the column of air which rests upon it. It follows, therefore, that this compression must become less as we ascend in the atmosphere, the superincumbent column becoming not only shorter, but also of less mean density. In fact, mathematical calculation, fully confirmed by experiment, proves that as the distance above the surface of the earth increases in arithmetical progression, the density of the air diminishes in geometrical progression. Hence we find that in very elevated positions the air has a great degree of tenuity. Thus at the monastery of the benevolent monks of Mount St. Bernard, 11,000 feet above the level of the sea, the air has its density reduced to less than two-thirds of that which it has at this latter level; and at the highest summit of the Himalaya mountains, which is at the prodigious elevation of 26,260 feet, or more than five miles, the density of the air is nearly reduced to one-third.

The enterprise of man has carried him to these vast heights, and it has been considered very remarkable that he should be able to bear, without sensible inconvenience, so great a change in the medium by which he is surrounded. It must be remarked, however, that to accommodate their elasticity to this new pressure, the solids and liquids of the body need undergo only a very minute change in volume. Thus when the pressure of the air is entirely removed from water, as in the well-known experiment of Canton, it expands only one part in 21,740; and it is probable that the solid and liquid constituents of the body would not experience a more considerable change under the same circumstances. As to the gases in the system, they are either in cavities which communicate freely with the surrounding air, or they exist in too small quantity to give rise to any inconvenience by their expansion. It is true that all travellers who have ventured into these elevated regions agree in stating that they were exhausted by the smallest exertion, and had to stop every few steps to pant and to recruit their strength. This, however, was no doubt principally owing, not to the change of pressure, but to the diminished quantity of air supplied to the lungs in respiration. The uneasiness may also in part arise from the extreme dryness of the air at great heights. It was of this, principally, that Gay-Lussac, who was not subjected to any personal exertion, complained, during his celebrated aërial voyage, in which he rose to the height of 23,000 feet, and had the mercury in his barometer standing below 13 inches.

The atmosphere is subject to great variations of temperature, constituting the diversities of climate and season. The source of the atmospheric temperature is the sun; though its direct rays have but little influence upon the air, which transmits them nearly all freely to the earth. Here, however, they are arrested, and the ground becoming heated communicates heat to the air in immediate contact with it, which is thus expanded, rises in the atmosphere by its superior levity, and is replaced by colder and heavier air. This, in its turn, is heated by contact with the ground, expands, rises, and is replaced. Thus a kind of circulation of the air is established, and by this indirect process the atmosphere derives its temperature from the sun. It is probable also that the air arrests a large part of the dark calorific rays which emanate from the heated ground; since it is an established fact that transparent bodies are much less permeable to these rays than to those which accompany the light.

As the heated air rises, it is subjected to less pressure, and consequently expands; and, if it retained its excess of temperature, it would always continue to be lighter than the surrounding air, and to rise; and thus the heat of the ground would be conveyed to the highest regions of the atmosphere. But it is proved by experiment, that as the density of air diminishes, its capacity for heat increases, or it requires a greater amount of caloric to heat it to the same degree. It follows, therefore, that from this cause, as well as from radiation, the air, as it rises, must have its temperature reduced, so that the higher regions of the atmosphere must always be colder than the lower. This reasoning is fully confirmed by observa-

tion. Hail is formed in the high clouds, in midsummer; very elevated mountains are covered with perpetual snow, even in the torrid zone; and the aëronaut, when he rises to a great height, always suffers from the cold, whatever be the season of the year.

The air is almost always in motion, thus forming more or less rapid winds. These are in general dependent, in the first instance, on variations of temperature; but many of the phenomena are also to be referred to the unequal absolute velocities with which portions of the earth in different parallels of latitude move, in consequence of the earth's rotation about its axis. The further discussion of this interesting subject must, however, be introduced under another article.

The atmospheric air is composed of two simple gases, oxygen and nitrogen, of which the former seems to be the true supporter of life in respiration. Chemists are not wholly agreed as to the exact proportion in which these gases enter into the composition of the air, though the general estimate is, that there are, in 100 parts by volume of atmospheric air, 21 parts of oxygen and 79 of nitrogen. Other chemists, however, among whom are Thomson, who seems to have employed in his experiments every means to insure accuracy, make the proportion of the gases 20 and 80, or as 1 to 4 exactly.

It has been a subject of much discussion, whether the constituents of the air were simply mixed together, or were united by a real though feeble chemical combination. The decision of this question must in part depend upon the true proportions in which the oxygen and nitrogen are found in the air; for it is a well-established law, that when gases combine chemically, they always do so in exact and simple proportions of volume. Thus, with regard to the two gases now under our consideration, 2 volumes of nitrogen united to 5 of oxygen form nitric acid, 2 nit. and 3 ox. form nitrous acid, 1 nit. and 1 ox. form nitric oxide, 2 nit. and 1 ox. form nitrous oxide. Now if Thomson's analysis be correct, atmospheric air would take its place, in the same series, as a compound of 4 volumes of nitrogen and 1 of oxygen.

A remarkable circumstance respecting the composition of the air, and one which greatly favours the opinion of its being a chemical compound, is the fact that the proportions of oxygen and nitrogen are always found to be exactly the same, in whatever part of the globe the air may be taken, and whether it be collected from the surface, from the deepest mines, or from the greatest elevation to which the balloon has ever reached.

Besides these constituents of the atmospheric air, other substances are met with, which, however, enter in small and variable quantities, and cannot therefore be considered as essential ingredients. One of these is carbonic acid gas, which is found in the proportion of one hundredth, one thousandth part, and even less, the quantity being dependent upon the situation, the season, and other circumstances. This gas is one of the products of respiration, combustion, and fermentation, and from these ample though variable sources, the air receives, no doubt, in part at least, its supply.

Hydrogen, in the proportion of one part in 10,000, has been found by M. Boussingault, in the air of Paris; and sulphurous acid gas is met with in the air of London. A flocculent organic matter is also said to be found in the air over marshy grounds. But these are unquestionably accidental admixtures.

Another substance which is always present in the atmosphere, and which acts there a most important part in the economy of nature, is the vapour of water. It was at one time supposed that the vapour was dissolved by the air, and held suspended in it as salt is in water. It is now known, however, that this notion is incorrect, that the air is passive with regard to the vapour, and that, at the same temperature, the same quantity of vapour exactly will be formed and suspended, over water, in the same space, whether it be a vacuum, or filled with air. The maximum of vapour in the air depends, in fact, upon its temperature alone. Thus, at 32° F., it may amount to 2.555 grains in a cubic foot, at 52° to 4.861 grs., at 72° to 8.977 grs., at 92° to 15.880 grs. In general, however, the amount falls short of this maximum, and the hygrometric condition of the air is indicated by the ratio between the quantity of vapour actually in the air, and the maximum quantity which it could contain at the given temperature.

When, by any means, such as the absence of the sun, the blowing of a cold wind, or the rising of the vaporous air in the atmosphere by its superior levity, the temperature of the air is reduced, it may be no longer able to contain, in the gaseous form, the vapour which had been before suspended in it, and then a portion of this vapour will be reduced to the state of a liquid, assuming the appearance of

fine globules floating in the atmosphere, and to which, as they are supposed to be hollow, the name of vesicular vapour has been given. When this vesicular vapour rests upon the surface of the earth, it forms mists and fogs; when it occupies the higher regions of the air, it forms the clouds. Sometimes, by an increase of heat, these liquid vapours are dissolved, and converted into true transparent gaseous vapour,—an occurrence witnessed in the dissipation of fogs by the presence of the sun. At other times, the accumulation becomes excessive, and the vesicles join together in drops, which finally fall to the ground in the form of rain. Frequently the vapour of the clouds is frozen, assuming the shape of feather-like crystals, and producing snow.

Though the air is eminently transparent, it must not be considered as completely so. Many of the solar rays are arrested by the air in their course, and reflected from it in all directions. It is, in fact, this reflected light that renders the atmosphere luminous, and which constitutes what is commonly understood by the term day-light. Were it not indeed for the light thus universally dispersed throughout the air, no bodies would be visible except those actually placed in the sunshine. It is this illuminated atmosphere also which renders objects visible before the rising and after the setting of the sun, and which thus forms the dawn and the twilight.

Although the air is capable of reflecting all the differently coloured rays, it is the blue which are reflected with the greatest facility, and in the greatest quantity. This is the reason why large bodies of air always present this hue, which is as much the proper colour of the air, as it is of the violet, and for precisely the same cause. Besides the colour of the sky, we have another evidence that blue predominates in the light reflected from the air, presented to us in the shadows cast upon the snow; for the snow in these shadows has always a decidedly bluish tint, and the light by which it is seen is only that which has fallen upon it from the air.

In this article, several subjects,—such as climates, seasons, winds, hygrometry,—have been incidentally introduced, which are of too great importance in their medical applications not to require a separate and much fuller discussion, for which, therefore, we refer the reader to the appropriate titles. R. M. Patterson.

Art. II. Atmosphere. (*Hyg.* and *Therap.*) No subject of Hygiène is more interesting than the influence of the atmosphere on human health,—considered either singly, or in combination with those local characteristics that occasion such a diversity in the salubrity of different countries, and of different districts of the same country. Whilst we observe the inhabitants of the more mountainous regions of our own country enjoying robust health, we may find those of the lower districts near the ocean, or dwelling on the banks of our larger streams, liable to diseases that are *endemic*, or the products of such situations; and daily observation instructs us, that the air of the city is not possessed of all those advantages for the preservation of health, which the more pure air of the country affords. We find, again, that particular regions of the globe are liable to diseases known only to them. The base of lofty mountains constitutes a locality almost everywhere favourable to the development of the *goître*, or "swelled neck." The smiling plains of Italy are saddened by the prevalence of the pellagra (*q. v.*), a loathsome cutaneous affection; and the plains of the torrid zone are infected with the yellow fever. All these diseases are connected with local causes, and are produced by particular conditions of the atmosphere, united with certain emanations from the soil, which last, indeed, have by some been looked upon as the sole cause of the difference of salubrity between different countries. (See *Climate.*)

Where a particular affection is universally prevalent in a locality, it must be presumed, that the "*constitutio aeris*"—as Sydenham termed it—is always favourable, and unites with other local causes so as to maintain the necessary causation; but where we observe a district—previously healthy—perhaps even signalized for its salubrity, devastated by a malignant disease, a precise union of the requisite atmospheric and local influences must be formed to induce it; and the reason why it never again occurs in such a district, or does so only after a lapse of years, is, that the necessary catenation of causes is wanting.

In this way, we account for the appearance of yellow fever occasionally in our seaports, and for its annual presence in the torrid regions of the globe. Unfortunately, as we shall find, it is easier to suggest the influences that occasion *endemics* and *epidemics* (see these words), than it is to explain the precise nature or operation of such influences.

On the main points of meteorology we

are signally deficient in information. There are physical circumstances that determine the shape of to-day's clouds, and a knowledge of which would have enabled us to prognosticate their presence; but this knowledge is far beyond our limited powers in the present state of science. Still more restricted is our acquaintance with the meteorological conditions that affect human health; nor can we indulge the expectation, that future improvements in science will enable us to possess an accurate knowledge of the subject. There are many interesting topics, however, connected with the matter, which we do know, and on which we possess much information of a valuable character.

It has been already shown, that the air, which everywhere surrounds the earth, and the total mass of which constitutes the *atmosphere*, is a ponderable, perfectly elastic fluid, consisting chemically of oxygen and nitrogen;—that, in addition to these chief constituents, carbonic acid can always be detected in it; and that it holds water in a state of vapour; caloric; the electric fluid; and a multitude of matters continually emanating from the earth, or from its animal or vegetable occupants. Into the influence exerted on human health, by its various and varying conditions, it is our present object to inquire.

§ 1. *Atmospheric Pressure.* The range of the barometer varies from about 28 to 31 inches; and if the changes are not extremely sudden between these extremes, the human frame is not very liable to suffer; but if we descend far below the surface of the earth, or ascend to a great height in the atmosphere, changes—especially if the range has been to a great extent, and suddenly experienced—may be produced in many of the functions, and more or less indisposition be excited.

Our acquaintance with the effect of great augmentation in the density of the air is comparatively more limited. The only means we possess of observing the former is in mines penetrating far beneath the surface, and perhaps in no case have these exceeded a league, and that not in a perpendicular direction, whilst the phenomena, attendant upon a rapid passage into a rarer atmosphere, have been observed at nearly 23,000 feet, or upwards of four miles perpendicular height.

Where the weight of the air is largely increased, as in mines, it is fair to presume, that the respiration should be slower, on account of the same quantity of oxygen being contained in a smaller bulk of air. It has been presumed, also, that the greater density of the air may constrain the inspiratory movements, so as to render them less frequent; but this, although specious, is conjectural.

It does not seem, that any augmented pressure, hitherto experienced in subterraneous excavations, has been attended with danger. Rostan, indeed, conceives it to be favourable to health. "To this," he remarks, "it may perhaps be objected, that in mines, the workmen, instead of being in better health, seem to be disadvantageously affected; but if we consider that, in such a case, the favourable action of the pressure is more than compensated by the mineral exhalations prevailing in these deep excavations, by the absence of light, hard labour, want of ventilation, &c., reasons sufficient may be found to explain why the unfortunate individuals, that are buried alive in these excavations, drag on a languishing existence, and die prematurely." (Rostan, Art. *Air*, in *Dict. de Méd.*, 1ère edition.)

Experiments with the diving-bell would throw some light on the effects produced by suddenly augmented density of the air, but here a source of fallacy exists, in the air being rapidly deteriorated by respiration,—the oxygen disappearing, and carbonic acid, which is directly unfavourable to animal life, taking its place. From this conversion, the respiratory movements would be speedily deranged, and the effects of defective aeration of the blood be soon apparent.

We have more numerous opportunities for witnessing the effect of diminution in the density of the air. If an animal be placed under the receiver of an air-pump, and the air be exhausted, the air within the body being no longer counterbalanced by the pressure of the air without, expands, the animal appears inflated, and soon dies. In the mammalia, birds, fishes, &c., death is occasioned from this cause, as well as from the want of a due quantity of oxygen in the rarefied medium surrounding them; but the amphibious animal, which is capable of subsisting for a long time without air, appears to be but little incommoded by its abstraction.

Many fishes are provided with an apparatus, called the *swim-bladder*, which regulates their specific gravity according to circumstances, and if they be placed under the receiver of an air-pump, the air in the bladder dilates until it bursts, after which they are unable to rise through the water, but crawl, as it were, along the

bottom. Biot asserts, that similar results occur to many kinds of fish, when taken at great depths, or even at the depth of from 70 to 100 feet. So long as they remain at the depth to which they are accustomed, the air of the swim-bladder has the degree of compression, and elasticity, necessary for supporting the column of water constantly pressing upon them; but if they be suddenly raised to the surface, the bladder swells, and bursts, and the air which it contained, occupying now eighty or a hundred times more space, fills the cavities of the body, forces the stomach out of the mouth, and kills them.

It is only, however, when the pressure is suddenly removed, that these phenomena are witnessed. When the transition is more tardy, the animal possesses the power of regulating the quantity of air contained in this receptacle, so that no evil can result.

Effects of a similar kind would be produced in the human body by any very sudden abstraction of the ordinary atmospheric pressure. It is the pressure of the air that prevents the escape of the fluids contained in the vessels; and if it be largely diminished, hemorrhages are apt to occur from those parts of the body where the vessels are least protected by the textures in which they creep, as in the air passages, and, indeed, in the mucous membranes generally.

The effect of diminished atmospheric pressure on a part of the body is well exemplified by the application of a cupping-glass.

The inconveniences sustained by ascending lofty mountains, are partly owing to the rapid passage from a denser to a rarer medium. Some, however, have affirmed that they, in no respect, depend upon diminished pressure, but upon the fatigue induced by the ascent. Bouguier, Haller, Rudolph, Meyer, and others, are of this opinion, and the Abbé Ferrara asserts, that none but invalids are incommoded on ascending to the summit of Etna. Londe, too, affirms, that he has scaled the highest peaks of the Pyrenees, without experiencing any inconvenience, except what arose from the excessive cold, and that the acceleration of respiration and circulation ceased after resting for some time; whence he, likewise, infers, that the effects are to be ascribed solely to the violent exercise of the ascent. On the other hand, we have the testimony of De Sayve, De Saussure, Hamel, Raymond, Von Humboldt, and numerous others, to show that fatigue could have had little or no agency; and what strikingly exhibits the accuracy of their deduction is, that the same inconveniences were sustained by Gay-Lussac in his celebrated aerial voyage, already alluded to. The indisposition experienced under such circumstances, is extremely common in South America, and is termed *sorocco*. Dr. Meyen—a recent German traveller—thus describes the effects produced on his party, during an expedition to the mountains of Peru. "We were tormented with a burning thirst, which no drink was able to assuage: a slice of water-melon, which we had brought with us, was the only thing we could relish, whilst our people ate garlic, and drank spirits, maintaining that this was the best way to guard against the effects of the journey. We kept on ascending till two o'clock in the afternoon. We were already near the little ridge, which extends W. S. W. from the summit of the mountain, when our strength at once abandoned us, and we were overtaken by the disease *sorocco*. The nervous feverishness under which we had suffered from the first had been gradually becoming worse and worse; our breathing became more and more oppressed; fainting, sickness, giddiness, and bleeding at the nose, came on; and in this condition we lay a considerable time, until the symptoms grew milder from repose, and we were able to descend slowly." (*Reise um die Erde* u. s. w. *in den Jahren* 1830, 1831, and 1832. Berlin, 1834.)

It is from the feelings experienced at such lofty elevations, that legitimate deductions with regard to the effect of the air at great heights can alone be drawn. At lesser elevations, the uneasiness sustained may be so trifling as scarcely to be felt by the robust; and hence the testimony of those who have ascended the Himālā mountains, or the Andes, is infinitely more satisfactory than that of the traveller who has merely climbed to the summit of the Pyrenees, the most elevated point of which is not more than 10,722 feet, whilst the Chipea-Pic of the Himālās, reached by Captain Gerard, is 19,411 English feet high; and Humboldt, on Chimborazo—the highest of the Andes—attained a height of 19,374 English feet.

These facts exhibit the inaccuracy of the idea of Cassini, that no animal can exist at the height of 2446 toises,—15,640 English feet. The observers sent out to measure the earth under the equator, lived for a considerable time on the sum-

mit of Pichincha,—15,939 feet above the level of the sea, and consequently 300 feet above the point mentioned by Cassini; and the same gentlemen, whilst encamped upon the mountain, frequently observed vultures soaring at the height of 1300 feet above them, or in an atmosphere where the mercury of the barometer was below 14 inches. The remark of Cassini was founded on the presumption, that the atmosphere, at the height of 15,640 feet, is one-half rarer than at the level of the ocean; and on the fact, that if the air be suddenly dilated one-half under the receiver of the air-pump, an animal, placed under it, dies. Such would doubtless be the effect upon man, if the density were as suddenly diminished; but we have multitudes of instances to show, that there is, within us, a capability of resisting injurious influences to a surprising extent, provided the system has even a short time for accommodating itself to the new circumstances under which it may be placed. Even the small period that elapses, in the ascent of a balloon to this giddy elevation, is sufficient for the purpose, and death, we have seen, did not result where the elevation, attained in this manner, was even 6095 feet greater than that indicated by Cassini as the limit of animal existence.

The highest town of any extent on the earth is Potosi in Bolivia—celebrated for the mines in its vicinity. It is 13,265 feet above the level of the Pacific ocean. Two hundred years ago, it is said to have contained 160,000 inhabitants, but the number is not now greater than 12,000. The highest inhabited spot on this hemisphere is perhaps the farm of Antisana in Quito, the elevation of which is 13,400 feet. Yet the human family are capable of subsisting at these lofty elevations with the same facility as amidst the arctic snows,—when once habituated to them,—inconvenience being felt by new settlers only, and even these, by the gradual ascent, have the different organs accommodated to the new external relations.

We have no observations to guide us regarding the comparative frequency of respiration and circulation in those who inhabit such elevated districts. The effect of a sudden change from a denser to a more rarefied atmosphere quickens, as we have seen, both one and the other, but much of the effect probably soon subsides. It is reasonable, however, to presume, that the respiration is permanently more rapid, in consequence of the rareness of the atmosphere requiring a greater number of inhalations, or, in other words, a greater quantity of air to produce the same effect in supplying the wants of the system. Nor are we better informed regarding the disposition to particular diseases, occasioned in the inhabitants of such regions, or whether there are any that can be legitimately ascribed to a permanent residence in an atmosphere more dense, or more rare, than that at the level of the ocean.

From what has been already observed, it will be conceived, that a sudden transition from a dense to a rare atmosphere must be unfavourable for such as are liable to hemorrhage from the mucous membranes, and especially from that of the lungs; and it is presumable that it might lay the foundation for serious chest affections; but this could only happen where the change had been rapid, and considerable, and it perhaps could scarcely apply to those who have been born and bred at such elevations as the town of Potosi. As regards them, the remark of Rostan (*Loc. Cit.*) is more than doubtful,—that "in a very rarefied air, thoracic inflammation, phthisis, aneurisms of the heart, and frequent hemorrhages, ought to be met with." Tourtelle affirms, that in 1768, and in 1770, the mercury continued at a great height, and epidemic inflammations of the chest, of the most fatal character, prevailed; and he adds, that the consumptive and the asthmatic are always incommoded by too dense an atmosphere. (*Elémens d'Hygiène*, 3ème édit. I. 233.) The same effect is ascribed by these writers to opposite causes, and the truth appears to be;—that changes in the density of the air, if not greatly above or below the ordinary, and not rapidly induced, are not attended with any marked effects upon human health, and that, in many instances, phenomena are ascribed to this cause, which are more properly referable, perhaps, to other meteorological conditions, existing together with, or independently of, barometric changes.

At the level of the sea, in our climate, the average height of the barometer is about 30 inches. At the height of 23,000 feet its mean elevation is about 12.95, but its height is different at different altitudes, and therefore the remark of Londe, that the density of the air best adapted for human health and longevity, ought not to cause the mercury to fall much under 28 French inches (nearly 30 English inches), and that an elevation of 2075 *mètres*—about 6800 English feet above the level of the sea—is unfavourable to health, is

untenable. The cities of Quito and Cuenza are at greater elevations than this, and Potosi at double the altitude. The elevated regions of Asia, however, afford us most striking examples of the impropriety of deducing general inferences of the kind alluded to. In the valleys and ridges of the lofty Himālā mountains, immense tracts, which according to seeming analogy, ought to be entirely barren, or perpetually enveloped in snow, are richly covered with vegetation, abound in animals, and are scattered with villages. (See *Climate*.)

Even the sanitary depôts, for those suffering under the diseases of the lower and hotter parts of India, are situated, in some instances, higher than the point assigned by LONDE as the limit to human health. Dargeeling, in the Sikkim mountains, 330 miles from Calcutta, has been recommended as a sanitarium. Its height is about 7218 feet above Calcutta, and its mean temperature is calculated to be 24° below that of Calcutta, and only 2° above that of London. A convalescent retreat has also been provided at Simla, a station among the hills between the Sutledge and Jumna, near Subhatto, and 7500 feet above the level of the sea.

§ 2. *Atmospheric Temperature.* The temperature of the atmosphere has probably a more extensive influence in modifying human health than its density. The range within which life can be maintained is great, and its vicissitudes are numerous. In our climate, the changes will occasionally amount to 40° and upwards in the twenty-four hours.

The capability of existing amidst the snows of the frigid zone, or in the burning equatorial climes, is one of the great characteristics of the human race; and it is surprising to reflect on the quantity of heat that must be constantly evolved by him in the former case, to resist the external cold.

In the temperate, and the colder regions of the globe, where the thermometer rarely or never attains the temperature of man,—that is, 98° or 100°,—the body must be constantly parting with its caloric; and where the spirit in the thermometer has stood at 55° below the zero of Fahrenheit's scale, as it did during one of the voyages undertaken by Captain PARRY in search of a north-west passage, the expenditure, in spite of appropriate clothing, must have been immense. It would seem, however, that in such cases the organs of calorification take upon themselves an increased action, and perhaps if the temperature of a resident in these inhospitable regions were observed, it would be found that the heat of his blood is some degrees hotter than that of the inhabitant of the more temperate, and the torrid regions. Analogy and observation lead to such conclusion. The quadrupeds of the frigid zone have a temperature higher than those of any other region of the globe. Captain LYON found the temperature of an arctic fox, recently killed, to be 106¾° Fahr., when that of the atmosphere was —14°. On the other hand, the capability of resisting high elevation of temperature is great. In another publication, the author has adduced numerous instances of the impunity with which air, at a temperature of 300°, and upwards, has been breathed for some time; but this is a temperature to which we are not liable to be exposed, except for purposes of science or of public exhibition. (*Human Physiology*, p. 196. 2d edition. Philada. 1836.)

In Virginia, the thermometer scarcely ever rises to blood heat. In many parts of the state there are a few days when it attains to 94°, and occasionally to 98°; but in South Carolina it has been seen as high as 115°, as well as in the Llanos or plains near the Orinoco. In Africa, the mercury is sometimes seen at 125°, whilst in British India it is asserted to have been as high as 130°. The highest temperatures of that region are met with in the great Western Desert, and other sandy districts at the level of the sea, or nearly so,—as the Circars, and the Lower Carnatic. ELPHINSTONE observed the thermometer at 112° in the Western Desert. HEYNE, in the Northern Circars, saw the mercury at midnight at 108°; and at 8 A. M. at 112°. This is probably the most elevated temperature that has ever been noticed in any region, whilst —55° may perhaps be regarded as near the point of greatest observed depression; the observed range of the thermometer, consistent with prolonged human existence, comprising, therefore, at least 185°.

In those cases in which the heat of the atmosphere is greater than that of the blood, we observe a compensating power exerted by the organs of calorification, so that the heat of the system is but little modified by it.

The human body is of course capable of being penetrated by the caloric from substances exterior to it, precisely as those substances themselves; but, within certain limits, it possesses the faculty of consuming, as it were, the heat, and of re-

taining the same temperature. We have elsewhere shown (*Human Physiology*, 2d edit. I. 92, and *Elements of Hygiène*, p. 47.) that even when the temperature of the atmosphere is not higher than our own, we experience the sensation of unusual warmth, yet no caloric is communicated to us. The cause of this feeling is, that we are accustomed to live in a medium of a less elevated temperature, and consequently to give off caloric habitually to the atmosphere.

In this climate, we are constantly parting with caloric, and in order to diminish the expenditure, and to obviate the sensation of cold, we have recourse to clothing, and, during the colder months, to artificial warmth; yet there is a range of temperature, in which, clothed as we are, no sensation of cold is experienced, even although heat may be disengaged from the body to some extent. The *comfortable* point varies, however, in different climates and seasons, and is greatly dependent upon the temperature which has previously existed. In this climate, it may be placed, perhaps, between 70° and 80°; but if the thermometer has ranged as high as 98°, or upwards, and has maintained this elevation for some time, a depression of 15°, or 20°, will give an uncomfortable sensation of cold, whilst we often observe, in spring, an elevation from 30° or 40° to 75° or 80° produce an oppressive feeling of heat. The arctic navigators, after having lived for some days in a temperature of 15° or 20° below 0, considered the air mild and comfortable when the mercury rose to zero.

We may consider, then, that it is *natural* for man to be subjected to a constant abstraction of caloric, and that his organism is adapted accordingly; but if, from any cause, the organs of calorification should become deranged, so that external heat, greater than that of the body, could produce its ordinary effects by conduction, or radiation, or both—as it does on inanimate objects—so as to raise the temperature twelve or fourteen degrees, the individual would die.

On the other hand, if the abstraction of heat from the frame were to be excessive, so that the calorific agents could not supply caloric as rapidly as it was expended, the temperature would fall; the fluids would congeal, and, when the temperature of the whole body was depressed to 79°, death would supervene.

It would appear, consequently, that the temperature of the animal body may be lowered beyond the natural much more than it can be raised, consistently with the persistence of vitality.

Independently of all other considerations, the elevated temperature of the torrid regions of the globe appears to be positively detrimental to animal health. The stimulation of heat, and constant evaporation by cutaneous and pulmonary transpiration, maintain the capillaries of the intestines in a state of irregular erethism, and disposed to assume a morbid condition under favourable exciting influences.

In this way, we account for the numerous derangements in the mucous membrane of the intestinal tube, which are so frequent in warm climates and seasons,—diarrhœa, dysentery, cholera, &c., with those universal attendants upon inflammation of the upper portion of the small intestine,—liver diseases. These are so common, that it is rare to meet with a case of fever in tropical regions not accompanied with bilious derangement. The excitement prevailing in the lining membrane of the duodenum, into which the biliary ducts pour their bile, is propagated along those ducts, and arouses the liver to inordinate secretion, or produces other functional or organic disease in that viscus. This state of irritation of the duodenum, induced, too often, by undue quantity or quality of aliment, is that of nine-tenths of the affections termed *bilious*. A person, after having dined heartily on a substance difficult of digestion, is affected with heartburn, distension, flatulence, great uneasiness in the epigastric region, and constant eructation; yet although the cause is manifest, he prefers to have the symptoms ascribed to a predominance of bile, rather than to a circumstance, the belief in which would tend to curtail him, in the slightest degree, of his enjoyments.

Fevers, dysentery, and hepatitis, or liver disease in some form, with every variety of bowel affection, may be regarded as the diseases of hot climates, and produced essentially by various irregular conditions of the dermoid system,—in which we include, the skin and mucous membranes.

That hepatic disease is capable of being induced by heat, we have proof in the animal kingdom. The celebrated *pâtés de foies gras*, made at Strasburg and Metz, and so much esteemed, that they are sent as far as Paris, Vienna, and even to St. Petersburg, are prepared from the liver of the goose, artificially enlarged by means of heat. The geese are crammed with food; kept from drink; nailed to a plank by the webs of their feet, and placed quite close to the fire; and in due time

the liver becomes greatly enlarged, owing perhaps to the excessive elevation of temperature diminishing the nervous energy, so that the digastric muscle, which composes the corpus callosum or gizzard, is unable to act with the necessary efficiency, and, for the same cause, the due secretion of the appropriate gastric solvent is not accomplished. The food, consequently, passes on into the small intestine, and, by the correlation of functions, the irritation perpetually excited by its presence, during this state of cramming, is communicated by the biliary ducts to the liver, so that hypertrophy is produced in that organ. But, howsoever excited, the application of heat, in this manner, scarcely ever fails to produce the condition of liver so *recherché* by the gourmand.

Similar remarks, to those made on the effect of an atmosphere of diminished density on the respiratory function, are applicable here. Warm air, being more dilated than cool, contains less oxygen in the same bulk, and consequently a greater number of inspirations is necessary to effect the requisite aeration of the blood. Such, at least, would be the result, if the temperature were to change suddenly from a cold, to a comparatively warm, point; but it seems probable, that under the protracted influence of an elevated temperature, the hurry of respiration subsides; the point of indispensable aeration is depressed; the lungs become less active, and less oxygen is consumed, the consumption being always found to keep pace with the degree of muscular exertion,—being, indeed, by many distinguished physiologists, considered dependent upon it. Certain it is, that the consumption of oxygen is largely augmented by muscular exertion, when not pushed to the extent of inducing fatigue. Séguin found it increased four-fold.

The effect of an elevated temperature in diminishing the consumption of oxygen has been proved by experiments on animals. Crawford found, that a Guinea-pig, confined in air at the temperature of 55°, consumed double the quantity which it did in air at 104°. He also found, that the venous blood, when the body was exposed to a high temperature, had not its usual dark colour; but, by its florid hue, indicated, that little change had taken place in its constitution in the course of circulation. In other words, the extreme arterial vessels, which appear to be the immediate agents of secretion, did not possess their wonted energy, but permitted the arterial blood to flow into the veins unchanged. Now these vessels, it is probable, are largely under the nervous influence, which, every circumstance appears to show, is considerably depressed when the body is exposed to great heat, and the difficulty of breathing, and sense of suffocation supervening under such circumstances, are mainly, perhaps, referable, as M. Georget has suggested, not to rarefaction of the air, but to debility of the inspiratory muscles, owing to the enervating effects of the elevated temperature on the nervous system. In this way, we account for the great lassitude and yawning induced by the summer heats; as well as for the languor and listlessness, and the indisposition to mental or corporeal labour, which are so characteristic of those who have resided for a length of time in torrid climes. How many individuals have sailed from their country to the scorching presidencies of British India, in the full exertion of youthful energy—intellectual as well as corporeal—and have returned to the land of their nativity, after a lapse of some ten or twenty summers, so thoroughly changed as hardly to have one characteristic remaining, and seeming to be devoid of all power of exerting either mind or body. (See *Climate.*)

To the young, and the vigorous, a moderately depressed temperature is agreeable and exciting. The first effect is to diminish the circulation in the capillary vessels of the surface; and to interfere, somewhat, with the process of cutaneous calorification, so far at least as regards those parts that are not well protected against the coldness of the atmosphere, by appropriate clothing; but reaction soon succeeds, either spontaneously, or aroused by exercise, and an agreeable glow follows the state of diminished calorification. This excited action at the sentient extremities of the nerves is appreciated by the brain, which responds to the stimulus; the play of the nervous system becomes more energetic, and, consequently, every function under its presidency acts with more than usual vigour. Perception is more acute; reflection more ready; and most of the nutritive functions are more energetically accomplished, with the exception of the cutaneous transpiration. The urinary secretion is, however, so largely augmented as to compensate for the defective depuration by the skin.

Such are the effects produced by a moderate cold;—for example, of one between 30° and 45° of Fahrenheit's scale—provided the exposure has not been

too long continued, and due exercise and clothing have been employed. When, however, the body is subjected even to this temperature, and *à fortiori* to a lower, without the necessary endeavours to counteract its influence, the subcutaneous circulation is impeded; secretion and calorification are retarded, or arrested; the skin becomes rough, and assumes the character of the *cutis anserina* or *chair de poule*, and the blood circulates in greater quantity in the interior of the frame, so that inflammatory or subinflammatory affections are apt to supervene, especially in the air-tubes, the lining membrane of which, in consequence of the diminished cutaneous exhalation, and circulation, has its vessels more engorged;—and hence the different forms of bronchitis;—cough, peripneumonia notha, winter cough, &c. —which prevail during the colder seasons, and prove so fatal to the aged especially.

It was asserted by BEDDOES,—and experience has corroborated his assertion,—that, during the coldest months, there is, in England, regularly the greatest number of deaths amongst those above 60 years of age; and Dr. WILLIAM HEBERDEN, Jun.,—a learned and accurate observer,—who published some interesting observations on the climate and diseases of London, has said, that one of the first things which must strike every mind engaged in the investigation of this subject, is, the effect of a severe frost on old people. "It is curious," he remarks, "to observe among those who are said in the Bills to die above 60 years of age, how regularly the tide of mortality follows the influence of this prevailing cause; so that a person, used to such inquiries, may form no contemptible judgment of the severity of any of our winters, merely by attending to this circumstance."

These views are somewhat applicable to our own climate. We should not, however, be justified in according with BEDDOES, that "during the coldest months there is regularly the greatest number of deaths among those aged above 60, and the fewest in the middle of summer." The latter part of the sentence is not in accordance with our experience. On the contrary, next in fatality to the pulmonary affections, induced by the severity of the winter's cold, we would class the disorders of the lining membrane of the intestinal canal, occasioned by excessive heat, which are highly dangerous in advanced life, owing to the exhaustion they occasion in a frame whose elasticity has been worn out by prolonged exertion.

The facts above mentioned should, however, induce elderly individuals to adopt every precaution, during winter, to keep the cutaneous exhalation and calorification—not now affected as in youth—active by appropriate clothing (especially when they are subjected to exposure), and by a well-regulated temperature in their apartments. The mode of accomplishing this object will engage us hereafter. (See *Clothing*.) Nor is less attention required in the state of first childishness,—in infancy. Direct observation shows, that the function of calorification is less perfectly accomplished the nearer to birth; and that the compensating power, which we notice to be possessed by the older child, and by the adult, exists to a limited extent only for some time after birth,—the temperature of the infant rising, and falling, according to the greater or less elevation of that of the medium which it respires, or in which it is placed, and, in this respect, resembling somewhat the cold-blooded, rather than the warm-blooded animal.

In this tender state, exposure to a cold atmosphere is apt to produce local irregularities in the action of the vessels, and various congestive, or inflammatory disorders, which the tender organism is not calculated to withstand, and, accordingly, it is found, that exposure to a cold atmosphere proves very fatal to infants not properly protected against its deranging influence.

Except in such cases, however, a pure, dry, cold air, invigorates the frame; and, if we find, that, during the season at which depressed temperature prevails, indisposition is prevalent, the circumstance may be explained more satisfactorily by other mutations in the atmosphere, in combination with diminished temperature, or alone. To this, however, we shall have occasion to allude hereafter.

When the temperature is still more depressed, than in the case we have considered, and the frame is not sufficiently protected against its influence, very different phenomena occur. Instead of an invigorating action, the nervous system becomes torpid; the brain ceases to be affected by impressions from without, and an irresistible desire for sleep comes on, which, if indulged, becomes the sleep of death, and is, perhaps, one of the easiest modes in which life departs from the body. (See *Cold.*)

§ 3. *Atmospheric Moisture.* There is another condition of the atmosphere, which —singly or combined with the others we have mentioned—exerts considerable influence over the functions. We allude to the *Hygrometric.*

As air possesses the property of dissolving water, all liquid bodies, when exposed to it, experience a certain degree of evaporation; the amount of such evaporation varying according to the degree in which water is already contained in the air.

It has been a question with physiologists, whether the air abstracts moisture from the animal body as it does from inorganic substances. They who think that the cutaneous and pulmonary transpirations are mere transudations, or dependent upon a physical permeation of fluid from within the appropriate vessels to without, and independently of all vital agency, believe in the affirmative; whilst they who regard those transpirations as altogether vital, consider that no such physical effect can result. Others, again, with more propriety, believe that the condition of the external air may concur in modifying the exhalation, even if it be regarded purely vital.

The supporters of the first opinion adduce the instances of fishes, which, if taken out of their proper medium, and kept for some time in the air, lose a considerable portion of their weight by this kind of evaporation, or transudation. M. EDWARDS affirms, that having endeavoured to prevent evaporation by placing a cold-blooded animal in a moist atmosphere, and at a temperature equal to that of the animal, so as to reduce the transpiration to that which was accomplished organically, or by the vital action of secretion, he found that the physical evaporation formed five-sixths of the ordinary loss by transpiration. ADELON, however, objects to any inference deduced from aquatic animals being applied to man;—"the former," he remarks, "are impregnated with water, and as soon as they are exposed to the air, permit it to transude." But such, he affirms, is not the case with man, in whom it is necessary, that the matter of transpiration should be secreted by appropriate organs, and be deposited on the pulmonary and cutaneous surfaces. He denies, also, that anything like physical permeation takes place in the living body. In another work, however, (*Human Physiology*, 2d edit. I. 42.) we have endeavoured to show, that the living tissues are penetrable, and that both imbibition and transudation take place in the living body. This, we think, is indisputably proved. But even were we to grant the position assumed by ADELON,—that the cutaneous and pulmonary transpirations are produced by vital agency alone, and in no respect to be assimilated to physical transudation, a great agency in modifying the quantity of these transpirations must be ascribed to the varying condition of the atmosphere as regards moisture. If the air be dry, its power of absorption is greater; the perspirable matter evaporates as soon as it is secreted; but when the air contains much moisture, the perspirable matter does not readily evaporate, but accumulates on the surface in a sensible state. In the former case, we should expect the activity of the exhalants to be increased by the ready removal of the secretion, and in the latter to be diminished, for opposite reasons.

It is not probable, however, that the main effect is induced in this way, but that the process is of a more physical nature, and that the body parts with the watery fluids, contained in the vessels, by simple transudation, although we are not prepared to deny, that a part of the result may be produced on the secretory vessels in the mode mentioned.

From what has been remarked, it can be easily understood why, in a warm moist air, we seem to perspire more than in a hotter and dryer, although we may really be exhaling less. It is asserted by SCHMIDTMEYER, that in the climate of Chili, notwithstanding the very high temperature in summer, the perspiration passes off so entirely in the insensible form, that, during the most violent exercise, it might be doubted whether any perspiration whatever exists.

If the air be greatly charged with moisture, especially during the heat of summer,—owing to a diminution of the cutaneous and pulmonary transpiration, the evaporation of which constitutes a cooling process, we feel languid and listless, with an indisposition to all mental and corporeal exertion. This is the cause why we suffer little more during the hot summers of this country, than in those of Great Britain, where the air is always more loaded with humidity, although the thermometer may be 15° or 20° higher here than there.

Again, when we are exposed to a moist temperature much greater than that of the body, we may seem to perspire profusely, whilst the cutaneous moisture may be chiefly owing to another cause.

In certain experiments instituted by Dr. Geo. Fordyce and Sir Charles Blogden, with heated air, they found in a temperature of 260° of Fahrenheit, that small quantities of water in metallic vessels speedily boiled, and that streams of moisture poured down the whole surface of the body; but that this was merely the vapour of the room, condensed by the cooler skin, the temperature of which was only raised a few degrees above the ordinary standard, was proved by the fact, that when a Florence flask, filled with water of the same temperature as the body, was placed in the room, the vapour condensed in like manner upon its surface, and ran down in streams.

On the other hand, when the air is cold and moist,—owing to aqueous vapour being a better conductor of caloric than air, the heat is abstracted in greater quantity from the frame, and we feel more chilly than the temperature, it would seem, is calculated to explain; and therefore more liable to have those disordered and irregular actions of the capillary system induced, which give occasion to different febrile and inflammatory disorders.

M. Edwards ascribes the uneasy sensations, experienced on the tops of lofty mountains, to the augmented evaporation from the lungs, produced by diminished atmospheric pressure, and great dryness. This great dryness of the air at lofty elevations was appreciated by Garcilasso de la Vega. "It is a well-known fact," he observes, "that the Adelantado Don Diego de Almagro, on his march towards Chili, when, as is probable, he was led by his guides over the highest plain of Tacora, lost more than 10,000 Indians, 150 Spaniards, and a number of horses, all of whom fell a sacrifice to hunger, thirst, and this disease. The soldiers in that memorable expedition built themselves walls of the dead bodies of their comrades, merely to protect themselves against the drying effect of the wind."

But facts, as M. Edwards judiciously observes, connected with an excessive evaporation from the lungs, may be observed in other than elevated regions.

In winter, when, during a very sharp cold, an apartment is warmed by means of a stove, a painful sensation is experienced by many persons in the chest. The air, in a frost, contains scarcely any watery vapour, and the heat of the stove, by augmenting the temperature of the air, increases its capacity for vapour, so that a much greater evaporation is produced than in summer. It is an old custom to place upon the stove a vessel of water to remedy the inconvenience, and the practice is attended with advantage.

It is probably by this abstraction of the moisture from humid bodies, that air acts as an irritant to wounded and ulcerated surfaces (see *Air*), and the great improvement which has taken place in the management of such cases has consisted in carefully excluding air, the admission of which occasions a rapid evaporation of the moisture covering them, and excites irritation in the vessels, whose office it is to effect the reparatory process.

The barometric and thermometric influence of the air is exerted with more or less energy upon the animal frame, according as its hygrometric condition is more or less considerable; that is, according as it is more or less dry or damp.

We have seen that the sensations of heat and cold, which we experience from the air, are greater when the air is damp, owing to the presence of water between its particles adding to its conducting power; and lastly, that as the dissolving power of the air augments in proportion to its dryness and temperature, its action upon the fluids of the body must be less in a moist than in a dry atmosphere.

It may be remarked, by the way, that a moist atmosphere is better adapted than a dry one for dissolving various animal, vegetable, or mineral substances, which are susceptible of volatilization. We have many instances to prove, that volatilizable substances are sooner converted into the gaseous state under such circumstances. Camphor is found to volatilize with much greater celerity in damp situations, and every one has noticed the fragrance of a garden after a summer's shower. There are certain bodies, too, which require the presence of moisture for their escape. Thus, the odorous particles of argillaceous substances are quiescent, until they are breathed upon, or, in other words, become moistened by the fluid from the lungs, or by moisture of some kind, after which the mineralogist readily recognizes their characteristic odour.

Every one must have noticed how powerfully the stench of putrid ditches is conveyed to the olfactory organs in summer, previous to rain, when the air becomes charged with moisture; and how readily offensive substances are detected in a fog by the same sense.

The agency of moisture is, doubtless, also concerned in the conveyance of the various emanations from the soil, that produce endemic disease. It has long been

noticed, that whilst the inhabitants of a plain, on the level of a marshy land, have escaped those diseases that are known to be produced by the emanations from such land,—or by *malaria* (q. v.), as it has been termed by the Italians,—those dwelling on neighbouring elevations have suffered extensively. Observation would seem to have shown, that this malaria is somewhat heavier than atmospheric air; but as watery vapour is incessantly exhaled from the surface of the earth under the influence of solar heat, and as this vapour possesses so little specific gravity, it takes up the miasmata along with it, and, under favourable circumstances, they impinge on these elevations.

The same reasons apply to the communication of the matter of contagion, which would appear to be modified in its activity by the degree of moisture in the atmosphere influencing its solubility and volatility; but on this topic our evidence is not quite as satisfactory. The same may be said of epidemic influences, of which our ignorance is unhappily so profound. It may be remarked, however, as some corroboration of this view, that the Harmattan, a wind which blows periodically from the interior of Africa towards the Atlantic Ocean, and which is characterized by its extreme dryness, is asserted to put an end to all epidemic and contagious affections—even to smallpox; and it is said that, at such times, infection is not easily communicable by art. We shall find, hereafter, that humidity modifies the action of atmospheric electricity on the animal body, as well as the electrical condition itself.

§ 4. *Atmospheric Vicissitudes.* It has been already seen, that in the varying atmospheric conditions, which have been considered, the system has the power of accommodating itself to the changes, provided they are not too extensive or sudden. But if the mercury were to vary at once from 28 to 31 inches, or conversely, it is difficult to say what might be the extent of the effects of such sudden vicissitude. Or, again, if the temperature should suddenly rise from $-55°$ of Fahrenheit, to $+130$, as a natural consequence of this rise the barometer would fall, and from these combined causes—even from the vicissitude of temperature taken singly—man might cease to exist.

Vicissitudes in the hygrometrical state of the atmosphere would probably be borne with the greatest impunity.

It can rarely happen, that these vicissitudes in the barometric, thermometric, or hygrometric conditions of the air, are experienced singly. It has already been seen, that as we ascend in the air, the atmosphere necessarily becomes lighter, the mercury of the barometer consequently descends, and, at the same time, greater and greater coldness is experienced according to the elevation, so that if we are ascending high mountains we ultimately attain the regions of perpetual congelation. We have seen, also, that at very great elevations, the air is much dryer, and that inconvenience is actually sustained from this cause. High up in the atmosphere, we have, consequently, a combination of a low state of barometric, thermometric, and hygrometric conditions.

Warm air, again, being more expanded, the barometer sinks in it, whilst a larger quantity of aqueous vapour can be held in the invisible state than when the temperature is lower.

These facts show, that the different atmospheric modifications, which we have considered, may be variously circumstanced so as to give rise to much of that peculiarity which we notice in different climates, and to the various mutations experienced in the air of the same district of country.

Vicissitudes in temperature are the most appreciable by our senses, and to them, consequently, our attention is most frequently directed. A rapid alternation from heat to cold is felt the most disagreeably, and we are disposed to refer numerous morbid conditions to it, especially if the cold be attended with dampness, which it is sure to be, if the vicissitude has been very sudden.

During the state of warmth, a large quantity of vapour may be retained in the air in an insensible form, which becomes apparent if the temperature suddenly subsides to an unusually depressed point.

Robust individuals may experience such alternations without detriment; but the delicate,—they who are liable to internal affections on slight irregularities,—often suffer greatly. It has been supposed, that much of this effect is owing to a sudden check to perspiration, and this may account for the mischief in many cases, but unless the change be remarkably rapid, the system will generally accommodate itself, so that the depuration, previously accomplished by the skin, may take place to a considerable extent from the urinary organs; for we have already seen, that in the winter months this depuration exceeds the cutaneous, whilst the contrary obtains in summer. Thus, the air may

continue, as it often does in winter, in this climate, for days together, largely below the freezing-point, and yet no evil, under ordinary precautions, may result from protracted exposure to it.

It does not, indeed, appear probable, that many of the maladies so often ascribed to depressed temperature or to taking cold, are owing to mere diminution in the *general* cutaneous exhalation, but rather, that they are ascribable to local irregularities of the capillary system, between all the parts of which there is such an extensive and intimate sympathy, that if one part be irregularly affected, another portion of the system, more disposed than the rest, owing to inappreciable circumstances, to assume morbid derangement, becomes implicated.

The probability of some evil, resulting from getting the feet wet, is proverbial; yet the effect, immediately produced by exposure, involves but a slight extent of surface. Still, if twenty people be exposed to this cause of disease, upwards of two-thirds will probably be attacked with inflammation or irritation somewhere. One may have one form of catarrh; another may have a second; another inflammatory sore throat; another pneumonia; another inflammation of the bowels, and so on; according as the capillary system of one part, in the particular individual, is more liable, at the time, to take on an increased action than the rest.

It has been generally asserted by writers, that a sudden vicissitude from heat to cold is likely to affect the bowels by *driving in* the perspiration, and occasioning it to settle on the mucous membrane of the intestinal tube. This does not appear to us to be good philosophy, although the fact of diarrhœa supervening under such circumstances may be indisputable.

We have seen, that the mucous membranes essentially resemble the skin in function, but they differ greatly in one respect. The cuticular covering of the skin impedes the absorption of substances from without, whilst the mucous membrane of the intestinal canal has the important office of absorbing all substances possessed of the necessary degree of tenuity. It is more an absorbing than an exhaling membrane. It is probable, therefore, that where a bowel-affection results from exposure to cold, under the circumstances mentioned, the excited action of the exhalants is caused by the lining membrane of the intestines sympathizing with the irregular action of the cutaneous capillaries, so that the membrane is not in a simple state of healthy exhalation, occasioned by the *driving in* of the cutaneous transpiration, but actually labours under inflammatory excitement or irritation;—for such is always present to a greater or less extent in these cases,—produced in the same manner as where a distant organ becomes irritated in consequence of an irregular action of the capillaries of the feet, in the case assumed above.

It need scarcely be remarked, that these effects, as well as all those that are produced by atmospheric vicissitudes, affect the feeble, and the convalescent, and those debilitated, and irritated by previous evacuations or disorders, more than the healthy.

Hallé, according to Bricheteau, was in the habit of referring, in his lectures, to the case of a physician, who was so imprudent as to expose himself to a vicissitude of 29° of temperature from warm to cold, after having been violently acted upon by a powerful cathartic. "The functions of the skin were suddenly arrested, and he died the next day of inflammation of the bladder." Such cases are not, however, singular. They are of every-day occurrence, and the observation of every individual could enable him to adduce many of the kind.

During the winter season, we frequently pass, even in a state of perspiration, from a heated atmosphere at 80°, or upwards, to one of 32°, on leaving a crowded assembly, and often without adopting the necessary protection against the cold; and many a victim has recorded the danger of such a transition to the delicate; yet it is surprising that the mischief is not even more extensive. There seems to us to be much less danger, in these cases, in passing into the open air, whilst the system is strongly heated, than after we have waited, as is the common practice, until we have become cool. Whilst the skin is hot and dry, the whole capillary system is in a state of activity, and if we pass into the cold, whilst this activity exists, we are better able to resist its depressing effects; and, accordingly, every one must have noticed, that he has suffered less under such circumstances than when he has waited until the organs of calorification have begun to act with less energy.

Let it be borne in mind, that these observations do not apply to that state in which the activity of the vessels has begun to subside, in consequence of perspiration, which is a cooling process, having been established. In such a case, the heat is undergoing resolution, and if we

expose ourselves to cold,—owing to that cause as well as to the irregular capillary action, apt to be excited by cold and moisture,—we have disease induced much in the same way as it is occasioned when the feet are exposed to those agents. The disease is not, however, excited by the check given to the general sensible perspiration, but is owing to irregular local action of capillaries, which, as we have already said, is one of the most common causes of morbid conditions of the various structures.

That a sudden check, given to sensible perspiration, provided there be, at the same time, exalted action of the capillaries, is not of itself likely to produce disease, provided the check be general, is proved by the effects of the Russian vapour-bath, of which Dr. Traill, of Liverpool, has recently given a description, from personal observation and experience. (See *Baths.*)

But, although vicissitudes from heat to cold are generally regarded as most frequent sources of disease, they cannot take place from cold to heat with perfect impunity; indeed, in certain cases, we observe the most unpleasant effects produced,—from exposing a frozen limb, for example, to the influence of heat. In such a case, the limb is in a state of torpidity; and if it be now subjected to external heat, the vessels, continuous with the obstructed capillaries, have their action excited; inflammation results at their living extremities, and the congelation becomes converted into irrecoverable mortification.

"Woe to the man," says Larrey (*Op. Cit.* IV. 134.), in his description of the unfortunate campaign to which we have previously alluded, "benumbed by cold; whose animal functions were nearly annihilated, and whose external sensibility especially was extinct, if he suddenly entered too warm a chamber, or approached too close to the large fires of the bivouac. The more prominent parts, benumbed, or frozen, and at a distance from the centre of the circulation, were struck with gangrene, which supervened on the instant, and developed itself with such rapidity, that its progress was sensible to the eye; or the individual was instantaneously suffocated by a kind of turgescence, which appeared to attack the pulmonary and cerebral systems. He perished as in asphyxia. In this way died the *Pharmacien-en-chef* of the guard,—M. Sureau. He had arrived at Kowno without accident, except that his strength was diminished through cold and hunger. An asylum was offered him in a very warm room in the *pharmacie* of the hospital. He had not been many hours, however, in this new atmosphere, before his limbs, which had lost all sensation, became tumefied, and puffy, and soon afterwards he expired in the arms of his son, and of one of his colleagues, without the power of utterance. Individuals were often noticed to fall stiff dead into the fires of the bivouacs; and every one who approached near enough to heat the frozen hands and feet, was struck with gangrene, wherever the cold had annihilated the vital properties."

When the effect of depressed temperature upon the extremities is to a less extent, diminishing merely the calibre of the vessels, and they are exposed, under such circumstances, to the heat of the fire, increased action takes place in the unaffected extremities of the blood-vessels that are continuous with the affected capillaries; blood is forced into them in undue quantity, and inflammation results, constituting the affection known by the name of *Chilblains* (q. v.).

It need scarcely be said, that a sudden and rapid change from cold to heat may develope irritations and inflammations in various structures, according to their predisposition, at the time, to be morbidly affected; and that hemorrhages, and other affections, occasioned by heat, and diminished atmospheric pressure, may be the result in such cases.

When the air, from being dry, becomes moist, those affections are apt to be developed, which are the product of moist air; and these, it will be recollected, differ according as the moisture is accompanied with elevation or depression of temperature. No inconveniences result from a sudden vicissitude from a moist to a dry air, so far as mere moisture is concerned. It has been already shown, that at high elevations much inconvenience is experienced from this cause, but, in such case, the dryness is extreme, and there are deranging influences of a barometric and thermometric kind operating at the same time. The remark is applicable only to the ordinary vicissitudes from moisture to dryness, which are experienced in any given locality.

It must not be presumed, that these vicissitudes in the physical characters of the air, when within the bounds of moderation, are detrimental to man. Without the changes effected by the seasons, it is obvious that animals would be deprived of the support they derive from the vege-

table kingdom; and, it is probable, if we lived in the state of perpetual spring, which has been imagined, by poets, as best adapted for animal existence and comfort, our enjoyments would be much less than they are at present. How monotonous would seem the succession of day after day! How devoid should we be of that buoyancy, and elasticity, which we experience, when the moisture of a foggy morning is dispelled by the rays of the sun, and all is life and gaiety! It may be said, indeed, that we should experience none of that languor, and lassitude, which a heavy, lowering atmosphere induces. This is true: but all our pleasures are relative, and the same intensity of comfort could not exist if all were sameness. We should become lazy, and listless; worn out with *ennui*, or depressed with melancholy; and as the stimulus would be wanting, which the constant mutation of the physical agents around us is perpetually applying to the frame, so as to maintain its various functions in energetic activity, we might probably be liable to more derangements than affect us at present, under all our atmospheric vicissitudes.

These very mutations, indeed, have been considered by one of the most distinguished of British philosophers (Sir HUMPHRY DAVY) as the cause of the mental activity, which he considers to characterize his countrymen. "Of all the climates of Europe," he remarks, in his "*Consolations of Travel*," "England seems to me most fitted for the activity of the mind, and the least suited to repose. The alternations of a climate, so various and rapid, continually awake new sensations; and the changes in the sky, from dryness to moisture, from the blue ethereal to cloudiness and fogs, seem to keep the nervous system in a constant state of excitement. In the changeful and tumultuous climate of England, to be tranquil is a labour, and employment is necessary to ward off the attacks of *ennui*. The English nation is pre-eminently active, and the natives of no other country follow their objects with so much force, fire, and constancy."

The vicissitudes of the temperate regions of the globe are so numerous, and often so unexpected, that it is impossible for us to guard well against their injurious effects. Some persons endeavour, as they say, to fortify their children from early infancy, so that they may resist them, or be less affected by them. It need scarcely be said, that all undue clothing, and residence in heated apartments, without change, must be liable to the objections we have urged against a monotonous condition of the physical influences around us; but, at the same time, it is not every infant, that will bear the plans employed by some parents to harden it;—such as bathing every morning in cold water; exposure to the air at all temperatures; light clothing, even when the air is cold, &c. Many an infant has fallen a victim to this persistence in error. Two-fifths at least of mankind die of acute diseases, and a large majority of these are induced by exposure to cold. If, however, the infant is habituated to daily tepid bathing, and ablution, for a time, and the temperature of the fluid be gradually depressed, until cold water alone is used; and if it be comfortably clothed, with flannel next its skin; and be sent into the fresh air, whenever the weather is serene—even if the temperature should be somewhat depressed—it may be accustomed to exposure as far as is prudent, and better adapted for bearing with impunity the vicissitudes of the weather, than where it is immured under the circumstances just referred to.

Similar remarks apply to the adult, who can expose himself to cold air with impunity, under ordinary precautions, provided he does not accustom himself to dwell in too heated apartments, and keeps the house whenever the thermometer is much lower than the medium heat of the climate.

§ 5. *Atmospheric Electricity.* The electrical condition of the atmosphere, and of the animal body, has, by many writers, been considered to be intimately connected with animal health, and the feelings are certainly much affected by it. Death even takes place, if we are situated so as to be connected with the discharge from a sufficiently-charged electrical cloud. Many persons, too, exhibit a manifest difference in the performance of their functions when the air is highly electric, and are apt to suffer considerably from headaches, and from pains of various kinds to which they may be subject.

If the air is very dry, and insulating, whilst the clouds are high, and at a great distance from the earth, all electrical communication between the earth, the living bodies attached to it, and the clouds, is intercepted, and no electrical phenomena are manifested. Under such circumstances, partly owing perhaps to these conditions, and partly also to favourable barometric, thermometric, and

hygrometric conditions, the individual feels full of energy and elasticity.

If, on the other hand, the air be charged with moisture, it becomes a good conductor of electricity, and there is a more free communication between the earth and the clouds. If the communication is very extensive, the equilibrium of electricity takes place insensibly, and without any apparent phenomena, except that a degree of languor and lassitude may be experienced, unconnected with muscular action, or disease.

If, again, the communication is not sufficiently complete, or not sufficiently extensive, proportionally to the electric charge in the clouds, the equilibrium is established by violent explosions, which give occasion to thunder and lightning; and if an animal be situated in the line of passage of the electric fluid, it may experience such a shock as will destroy it. Independently, too, of the electricity which is communicated by conduction, bodies are affected by induction,—in such sort, that if a cloud, highly charged with electricity, approaches the earth within the requisite distance, the earth becomes charged with opposite electricity.

It is not improbable but that the varying conditions of the atmosphere, as regards its electricity, may, in conjunction with the other states that we have considered, be very largely connected with the prevalence of particular diseases, which affect districts of country during particular years and seasons, and not during others. We shall see, hereafter, however, that our knowledge of *epidemic* diseases, or those which, in the present state of science, are referred to modifications of the *constitutio aeris*, is extremely limited. (See *Epidemics*.)

Dr. Forster, who, in his various essays on atmospheric phenomena, has much that is interesting and logical, with much that is fanciful, is of opinion, "that it is not the heat, nor cold, nor dampness, nor drought of the air, which is chiefly concerned in producing disorders, nor the sudden transition from one to another of those states; but that it is some inexplicable peculiarity in its electric state." The pain, felt in limbs which have been formerly broken, previous to a change of weather, and the disturbed state of the stomachs of many persons, before and during thunder-storms, are sufficient, he thinks, to warrant such a conjecture. It may be so, but we do not see why the diminished pressure of the air, in these cases, with its altered hygrometric condition, might not explain the indispositions to which he alludes, as well as those other pains, and aches, which are proverbial, as indicating some change of the weather, when the air has been previously dry, and dense,—such as rheumatic pains, tooth-ache, shootings, and tenderness of corns, &c. (See *Electricity*.)

§ 6. *Atmospheric Vitiations.* The air is liable to various admixtures which materially modify its action upon the animal economy, and to vitiations from different chemical changes effected in it by natural causes. The changes produced in the air by respiration and combustion, and the injurious effects experienced by animals, when restricted to a confined space, from the generation of carbonic acid thus formed, have already been noticed. (*Asphyxia*, p. 489–491; see also, *Carbonic acid gas*.) Even in large apartments, when crowded, artificially heated, and well lighted, inconveniences, as hurried respiration and circulation, giddiness, &c., are not unfrequently experienced from the presence of the gas just named. The lights burn dimly; the healthy and the strong feel oppressed, whilst the more feeble and delicate swoon; but owing to the facility with which the air of our apartments is changed, it cannot often happen that it is so much deteriorated as to occasion fatal results, or even serious inconvenience. Yet, as Dr. Hodgkin has suggested, the constant and frequent application of the cause cannot fail to produce injurious effects, and it is not improbable that the unhealthy appearance of the poor, who have large families crowded together in small and ill-contrived chambers, and more especially the sickly state of their children, originate, in part, in its agency. (*Lectures on the means of promoting and preserving health*, &c., by T. Hodgkin, M. D. Lond. 1835. p. 15.) All living bodies, when confined in a restricted space, deteriorate the air so much as to render it unfit for the maintenance of the healthy function. If animals be kept crowded together in ill-ventilated apartments, they speedily sicken. The horse becomes attacked with *glanders*; fowls with *pep*; and sheep with a disease peculiar to them, if they be too closely folded.

Jail fevers, hospital fevers, camp fevers, *all* owe their origin to the deteriorated air of these places;—deteriorated by the formation of carbonic acid gas, with the various animal exhalations and excretions, with which the neighbourhood of the body must necessarily be imbued, where

thorough ventilation is impossible. (See *Malaria.*)

The atmosphere sometimes contains an admixture of *carburetted* or *sulphuretted hydrogen gases*, both of which exert a lethiferous influence on the animal system. (See *Hydrogen gas.*)

The air is apt, also, to be loaded with emanations from animal and vegetable substances in a state of decomposition, and these occasionally act in a morbific manner; giving rise to typhoid and other affections. There are also many trades, —such as those of the gutspinner, the hartshorn manufacturer, the dealer in cats' and dogs' meat — technically called a *cracker*—which are carried on in putridity; but we shall endeavour to show, under another head (see *Malaria*), that the admixture of such emanations with the air does not affect public salubrity to such an extent as might be imagined; although the nervous, and the delicate, before they become accustomed to the offensive odours, may be more or less disagreeably impressed. The same may be said of the butcheries, dissecting-rooms, and cemeteries.

In many occupations, too, the air is apt to be vitiated by mineral emanations, and, in others, minute particles—animal, vegetable, or mineral—are mixed with it, enter the lungs, and occasion the peculiar effects of those substances on the system; or irritate the lungs in a chemical or mechanical manner,—but the consideration of their effect on health will fall more properly under another head. (See *Occupations.*)

We have yet to attend to those conditions of the air,—totally inappreciable by endiometric researches,—which give occasion to epidemic, endemic, and contagious diseases, and on which, unfortunately, the information we possess does not enable us to pronounce very definitively.

The medical profession have adopted three terms to express their leading ideas of the causes of diseases that affect large portions of the community, and are manifestly connected with the air, situation, or community.

Those causes that seem to be seated wholly in the atmosphere, and affect a more or less considerable extent of country, unconnected with locality, are said to be *epidemic* (q. v.); those that are connected with locality only, are called *endemic* (q. v.), and such as are produced by some emanation from an individual labouring under a similar disease are said to be *contagious* (q. v.),—the diseases resulting from those respective causes being termed *epidemic*, *endemic*, or *contagious*. Now, it will be obvious, that these causes may not act singly in all cases, but may be, and frequently are, combined. For instance, there may be something in the locality, connected with a favouring state of the atmosphere, which may occasion one place to be insalubrious, whilst others, in the immediate vicinity, are entirely healthy. (See *Localities.*)

Again, there may be a constitution of the atmosphere favourable for the extension of a disease, which is unquestionably contagious; or the causes of the extensive spread of such disease may be of an *epidemico-contagious* character. (See *Contagion.*)

In all cases of endemic disease there must be some modification of the atmospheric condition, or of the air of the locality; but such modification, as we shall find (see *Malaria*, and *Endemics*), has, in every instance, escaped the researches of the chemist, *material*, as it unquestionably must be. These failures do no more, however, than indicate the imperfect condition of chemical analysis. That certain agents exist in the air is sufficiently shown by their effects, and the day *may* arrive when we shall be enabled to detect them.

On epidemics, as on endemics, the discrepancy of writers sufficiently exhibits the want of fixed ideas. Whilst some refer them to excessive atmospheric heat, others have ascribed similar affections to cold. Dryness, and moisture, and opposite states of electricity, have also been invoked to account for the same phenomena. Nor are our ideas more fixed with regard to the circumstances that favour the spread of contagious diseases, and to the constituents of any emanation from the subject of any contagious disease.

§ 7. *Change of Atmospheric Influences.* We have already referred to the fanciful notions, entertained by certain writers, on the subject of medium temperature, and attempted to show, that it was neither well adapted to vegetable nor animal existence. It is probable, indeed, as was then remarked, that the different barometric, thermometric, hygrometric, electric, and other vicissitudes, when within due bounds, are actually conducive to health.

Who, that has breathed the deteriorated air of the crowded city,—less subject, certainly, to thermometric vicissitudes than that of the country, and deficient in the

intensity of light to which the rural resident is perpetually exposed,—has not experienced the cheerful, invigorating effects of a short visit to the pure air of the country, where all the physical circumstances of the atmosphere, which are susceptible of modification, are changed?

What is this but a vicissitude! Yet how advantageous the results! The spirits are exhilarated; nervous depression, produced by monotony, rapidly disappears, with the ills dependent thereon; and all is buoyancy and elasticity, where languor and lassitude before predominated. The civic "etiolation" or blanching, marked upon the countenance vanishes, and the ruddiness of rude health usurps its place; the appetite becomes augmented, and the powers of nutrition are largely increased, —as is indicated by the increase of weight which follows a sojourn, ef even a week or two, in a pure, salubrious region.

A great deal of the effect is produced simply by *change of air*, or by the altered feelings produced by a modification of the different atmospheric influences; so that the change from a better to a worse air has even been found serviceable. In Edinburgh, the inhabitants of the most airy parts of the New Town frequently send their children — when labouring under hooping-cough,—to the Cowgate, a filthy street, which runs at right angles under one of the largest thoroughfares of the Old Town; and in which, at a certain hour of the night, the inhabitants eject all the offensive accumulations from their houses, to be washed away by the waters of the reservoirs, let on for the purpose.

In all diseases, in which the affection appears to be kept up, in some measure, by habit, and especially in those that implicate the nervous system, change of air is proverbially beneficial, and, in this, all observers acquiesce. The multitudes of valetudinarians, who annually leave their habitations to visit the watering-places of this country and of Europe, and who return to their homes in the enjoyment of health, and full of confidence in the virtues of the waters, *near* which they may have resided, and of which they may, or may not, have partaken, are strikingly confirmative of the position. It is probable, indeed, that a great portion of the salutary effects ascribed to the springs is dependent upon change of air, and other extraneous circumstances. Long before the citizen of our Atlantic towns reaches the Alleghany Springs of Virginia, he has an earnest of the advantage he is about to derive from change of air, and many a valetudinarian finds himself almost restored during the journey—fatiguing as it is—through the mountain regions, which have to be crossed before he reaches the White Sulphur Spring, in Green Briar county. A large number, too, of individuals, cannot drink that water with impunity, and who are consequently indebted for their improvement chiefly to change of air, but somewhat, also, to varied scenery, and society, and to greater regularity of living, perhaps, than they have been accustomed to. In making these observations, we do not mean to affirm, that mineral waters—as in the case of the valuable spring in question—may not be important agents, occasionally, in the cure of disease; but, taking invalids in general, we are satisfied, that more is dependent upon change of air than on the administration of the waters. The inhabitant of one of the Atlantic cities, or indeed of any district to the east of the Blue Ridge, removes from a hot, malarious country, to one which is comparatively cool, and where all the diseases that are common to hot and malarious climates are extremely infrequent, and many of them unknown. The advantage is obvious. He escapes the diseases which would almost inevitably have attacked him had he remained, through the summer, in his unhealthy locality, and hence the wealthy families of lower Virginia are accustomed to spend those months in the mountain regions, in which they are especially liable to disease in their own malarious districts.

We can thus understand the reputation acquired by the Bath, and Matlock waters; the latter of which has scarcely any solid ingredient, and yet what crowds flock to those agreeable retreats! to the former, for the perpetual amusements, that keep the mind engaged, and cause it to react beneficially on the bodily malady; to the latter, for the enjoyment of the beauties of nature, for which Derbyshire is so celebrated. It is obvious, that were such waters bottled, and sent to a distance, so that the invalid might drink them at his own habitation, the charm would be dispelled. Not many years ago, amidst the bubbles that were engaging the minds and the money of the English public, it was proposed to convey sea-water by pipes to London, in order that the citizens might have the advantage of sea-bathing, without the inconvenience of going so many miles after it. Had the scheme been carried into effect, the benefits from metropolitan sea-bathing would

not have exhibited themselves in any respect comparable to the same agent employed at Brighton or Margate.

It would seem, that a mere change of the physical circumstances of the atmosphere, in which we are habitually placed, is advantageous to the economy, and that the vital powers act with increased energy whenever we leave a locality, to which we have been long accustomed, and where the functions are monotonously executed, and pass to one differing essentially from it: nor is it always necessary, as we have seen, that this difference should be "essential." Dr. Clark remarks (*Influence of Climate*, 2d edit. p. 234.), that notwithstanding the uniformity of temperature, which prevails among many of the West India Islands, the effect of a change from one to another is often very remarkable in improving the health,—a fact frequently observed, on a large scale, among the British troops stationed in the West Indies; and he considers, that one of the most powerful means for diminishing the sickness among the troops in that climate, would be to remove them frequently from one island to another. Such mutation would seem, also, to be indispensable in our aliments (see *Food*), where we may have been accustomed to variety,—and if we are restricted to one only—however nutritious and wholesome it may appear intrinsically to be—sickness is induced.

Discrimination is, of course, necessary in prescribing change of air as a therapeutical agent. It is inadmissible during the existence of acute affections in general, but when the violence of the disease has passed away, and when the inflammation—especially if of the mucous textures—has become chronic, we have no means to which we can have recourse, that are calculated to exert a more beneficial influence, under proper precautions, than a modification of the atmospheric influences surrounding the patient. Hence it is, that travelling, which combines change of air with proper exercise, is so salutary in chronic irritation of the mucous membrane of the intestines, and of the bronchi. Many of the cases, indeed, that have been looked upon as phthisis removed by this course, have been cases of chronic bronchitis. When the patient,—as Dr. Clark properly remarks, in treating of the utility of change of air during convalescence, and the remark is equally appropriate to the states of disease just mentioned—resides in a crowded city, or other confined situation, the change is more urgently called for, and, under such circumstances, many cases of severe disease occur, complete restoration from which is not effected without change of air. "The person, deprived of the benefit of such a measure, attains only to a degree of health inferior to that which he enjoyed before the occurrence of his disease; and the remainder of his life is often little better than a state of improved convalescence." (Art. *Air*, in *Cyclopædia of Practical Medicine.* London, 1832.)

It is in such cases, that the inhabitants of our cities, convalescent from acute diseases, or labouring under chronic affections, kept up, as it were, by habit, find so much advantage from a trip to our mountain regions, especially to the Trans-Alleghany Springs, where, as we have seen, everything around them is modified: advantage is soon and signally apparent.

Of the good effects of change of air in hooping-cough, mention has already been made. These are most strikingly exemplified when it is had recourse to after the disease has continued for some time, and the febrile symptoms, which so often attend the first period, have passed away. The change from one room of the house to another appears to be salutary, and even, as we have before seen, from a pure air to one that is less so.

In every form of impaired digestive function, change of air can be invoked with advantage, and, when combined with travelling exercise, the benefits are marked.

A recent writer, in pointing out the decided and obvious influence of travelling on the digestive function, and, through it, on the constitution at large, goes so far as to affirm his positive belief, that the most inveterate dyspepsia—where no organic disease has taken place—would be completely removed, by a journey of two or three thousand miles through Switzerland, Germany, or any other country, "conducted on the principle of combining active with passive exercise in the open air, in such proportions as would suit the individual constitution, and the previous habits of life." (Johnson, on *Change of Air*, p. 30; and the Author's *Elements of Hygiène*, p. 156.)

In amenorrhœa, and in other states of the uterine system, connected with atony, the exciting influence of new atmospheric conditions, new scenes, and occupations, are amongst our most valuable resources; and in dysmenorrhœa, become inveterate by habit, these influences will occasionally break in upon the morbid catenation, and

if the female should marry, or, being married, should be fortunate enough to pass one menstrual period without suffering, she may become pregnant, and the resulting gestation may completely remove the mischief, by eradicating the morbid habit.

In most of the diseases affecting the nervous system, and especially in those often characterized by great mobility, and irritability,—epilepsy, chorea, hypochondriasis, &c. — the new impressions, excited by change of air, society, and scenery, are strikingly useful, especially if the diseases have been connected with a sedentary life in a confined situation. In all such cases, as Dr. Clark has observed, this is a remedy for which we have no adequate substitute. "But change of air," as the same writer judiciously adds, "is not more valuable as a remedy in the cure of disease, and its consequences, than as a preventive of disease, more especially in childhood and youth. At this tender and susceptible period of life, the rapid influence of the atmosphere in which we live, in deteriorating or improving the health, is very remarkable; a change of a few weeks from the country to a large town being often sufficient to change the ruddy, healthy child, into a pale, sickly-looking creature, and *vice versâ*. The comparative influence of a town and country air on the health of children is seen in a striking manner in the families of the higher ranks of society, who spend a considerable part of every year in town. Children should never be reared in large towns, when this can be avoided; and when unavoidable, they should be sent, during a part at least of every summer, into the country, which, indeed, is the proper place for children, until their system has acquired sufficient strength to resist the injurious effects of city life. When they cannot have this advantage, we consider it the duty of the medical attendants of families to urge a temporary annual residence in the country, as essential to the health of children, more particularly those who are delicate. How many neglect this invaluable means of improving the health of their offspring, who have it in their power, and would willingly adopt it, were they aware of its importance! So strongly, indeed, are we impressed with the value of this measure, from ample observation, that we consider parents resident in towns, who have the means of giving their family the advantage of country air, and neglect it, deficient in one of their chief duties. To young females, who, by the habits of society, are much more confined to the house than boys, a temporary annual residence in the country becomes a measure of still greater importance, and should be continued at least to the full period of their growth. We have reason to believe, that the advantages of country air to the young, and delicate, are not sufficiently appreciated by the profession, and we are therefore anxious to call their attention to it, that they may use their influence with the public, upon whose minds, if they succeed in impressing the full value of pure air, they will be the means of contributing greatly to the health of the rising generation." Such has long been our impression, and for years we have acted upon it wherever it has been practicable. Independently of the signal benefits derived, by the young especially, from simple change of atmospheric influences, the large proportion of children who die under the age of two years, in towns, compared with the country, sufficiently exhibits, that the air of towns acts upon them deleteriously, and hence the necessity for moving them into the country,—during the heats of summer, especially,—when the infantile mortality is greatest.

The above remarks apply to change of air, abstractedly considered,—such as the same country or district is capable of affording. Under another head (see *Climate*), the effects of a total and more permanent mutation of atmospheric influences, on both the healthy and morbid condition, will be canvassed.

Bibliography.—The different writers on Hygiène.

Robley Dunglison.

ATOM. (From α priv. and τεμνω, I cut.) The ultimate or smallest particle into which matter can be divided. I. H.

ATOMIC. Appertaining to atoms. I. H.

ATOMIC THEORY. In chemistry the theory which maintains the existence in matter of physically indivisible particles called atoms; and which explains the *laws of combination* by supposing that the chemical elements unite by these particles when they form compounds. The laws of combination relate either to the proportions in which substances unite with one another, or to the proportion which the different quantities bear to each other, in which the same substance is found capable of uniting with some other substance. The proportions in which substances unite with one another are defi-

nite, and not by insensible gradations, and have this peculiarity, that they may be denoted by a series of numbers representing a succession of ratios, which are not independent of each other but connected throughout like the different links of the same chain. When these numbers denote the ratio of the weights of the constituents in what is considered a primary combination, they are called *equivalent numbers* or *chemical equivalents;* because they represent the relative weights in which the different chemical substances combine with or decompose each other, and are, therefore, in that sense of *equal value.* They are sometimes called *proportional numbers*, and *combining weights.* The ratios of combination having this equivalent property, are called *equivalent proportions.*

The equivalent numbers represent the ratios in which both the elementary and compound bodies unite; but the equivalents of the compound bodies are erected exclusively upon the equivalents of the elements as a basis, and are regulated by them. This will clearly appear when the fact is adverted to that the equivalent of a compound is merely the sum of the equivalents of its elements; and that the numbers obtained by this simple process of addition for any two compounds will necessarily represent the proportion in which such compounds will unite with one another. The equivalents of compounds being thus deduced, it follows that it is of chief importance to ascertain the equivalents of the elements.

It has been stated above that the laws of combination relate also to the proportion which the different quantities bear to each other, in which the same substance is capable of uniting with some other substance. To descend to particulars, it is found that in not a few instances, the same substance will form two or more combinations with some other substance taken at a constant quantity; and the relation which the several quantities of the varying substance bear to each other in its several combinations may be noticed. Now it is found invariably that this relation is a simple one, and may be denoted by numbers which have a simple ratio to each other. Thus, for example, the relative quantities of the varying ingredient which enter into combination, supposing two combinations, may be as 1 to 2, as 2 to 3, or 3 to 5; or supposing three combinations, as the numbers 1, 2, 3. In all these cases, either all the higher quantities are multiples by a whole number of the lowest quantity; or all the quantities are multiples by a whole number of some number. To denote this remarkable relation in the numbers, expressive of the different quantities of the varying ingredient uniting in several proportions, it is said to unite in *multiple proportions.*

The laws of combination may, therefore, be said to embrace the two general facts of *equivalent proportions* and *multiple proportions;* the former denoting the relation in quantity of different substances when combining; the latter, the relation of the different quantities of the same substance in its several combinations with another substance. But it may be asked why have the numbers representing chemical combinations these remarkable properties; why are proportions *equivalent*, and why are they *multiple?* The answer to these questions leads at once to the supposition that substances unite by certain particles or atoms which have different weights, in other words to the adoption of the *atomic theory.*

The more remarkable properties of *equivalent proportions* are that they are expressed by numbers which have a fixed and invariable relation to each other, and that they form a chain of ratios connected throughout. Now, if it be supposed that substances, when they form combinations, unite by their ultimate particles or atoms assumed to have different weights, the same fixed relation and equivalent property of the numbers denoting the combining quantities would obtain. Thus it is found that hydrogen and oxygen, to form water, unite in the fixed proportion of 1 to 8; and if it be supposed that, in this combination, the ultimate particles or atoms of the elements unite, they having the relation in weight of 1 to 8; then the relation of the quantity of hydrogen to the quantity of oxygen in any given portion of water, would be precisely the same as that ascertained by experiment. It is thus shown that the supposition of an atomic mode of combination satisfactorily explains the remarkable properties of the equivalent numbers; while no other supposition is sufficient to explain them. Hence it is reasonable to conclude that the atomic theory furnishes a true explanation of the peculiarities observed in these numbers, as denoting the proportions in which chemical substances unite.

It may be next proper to inquire how far the atomic theory is adequate to explain *multiple proportions*, the other law of chemical combination already adverted to. Here the remarkable property ob-

served is that the different quantities in which one substance will combine with another substance, bear a simple relation to one another, called a multiple relation. To adduce the simplest case of this kind, let us suppose that oxygen, according to its equivalent number 8, unites the nitrogen, according to its equivalent number 14; and that in a second combination, 16 of oxygen unites with 14 of nitrogen. From the explanations already given, it will be understood that 8 and 14, being equivalent numbers, represent respectively the relative weights of the atoms of oxygen and nitrogen. But the different quantities in which oxygen combines with nitrogen in the two combinations indicated, are represented by 8 and 16; and it is natural to inquire, why have these numbers so simple a relation to each other? The quantity of oxygen in the first combination being 8, why is its quantity in the second combination exactly 16, or twice 8, and not a little more or a little less? Now the theory of atomic combination answers these questions in the most satisfactory manner. The equivalent quantity of oxygen 8, represents the weight of an atom of oxygen. If then more than the atom of oxygen 8, is found to unite with nitrogen in the second combination, the increase cannot be any *fractional part* of 8, without dividing an atom; and the division of an atom, from its very nature, is held to be impossible; but the increase may be the *whole* of 8, because that number represents an *entire* atom; and hence, the quantity of the oxygen in the first combination being 8, its quantity in the second may be 16. Here then the multiple relation of 16 to 8 is fully explained by admitting that the 8 represents the weight of one atom, and the 16, the weight of two; and the absence of any intermediate proportions is equally well explained by the property of indivisibility, ascribed to an atom. Thus then multiple proportions in chemistry are satisfactorily accounted for by supposing combination by indivisible particles, or atoms.

In the foregoing remarks we have endeavoured to show that all the peculiarities observed in equivalent and multiple proportions are accounted for by supposing that substances combine by their atoms. Such a mode of combination, though universally admitted by chemists as a just representation of the manner in which substances unite, cannot, in the present state of science, be proved to take place. Hence the explanation of the laws of combination, that they depend on the fact that chemical substances unite by their atoms, is called the atomic *theory*.

Subjoined is a table of the equivalent numbers of the 54 elementary substances at present known, taken from the last edition of TURNER'S *Chemistry*, and corrected by the new edition of BERZELIUS'S *Théorie des Proportions Chimiques*, published in 1835. It will serve to give the reader a general idea of the numbers which express the experimental combining weights of the several elements, and which are generally supposed to represent the relative weights of their atoms.

Aluminium	13.7
Antimony	64.6
Arsenic	37.7
Barium	68.7
Bismuth	71.
Boron	10.9
Bromine	78.4
Cadmium	55.8
Calcium	20.5
Carbon	6.12
Cerium	46.
Chlorine	35.42
Chromium	28.
Cobalt	29.5
Columbium	185.
Copper	31.6
Fluorine	18.68
Glucinium	17.7
Gold	199.2
Hydrogen	1.
Iodine	126.3
Iridium	98.8
Iron	28.
Lead	103.6
Lithium	6.44
Magnesium	12.7
Manganese	27.7
Mercury	202.
Molybdenum	47.7
Nickel	29.5
Nitrogen	14.15
Osmium	99.7
Oxygen	8.
Palladium	53.3
Phosphorus	15.7
Platinum	98.8
Potassium	39.15
Rhodium	52.2
Selenium	39.6
Silicon	7.5
Silver	108.
Sodium	23.3
Strontium	43.8
Sulphur	16.1
Tellurium	64.2
Thorium	59.6
Tin	58.9
Titanium	24.3
Tungsten	94.8
Uranium	217.
Vanadium	68.5
Yttrium	32.2
Zinc	32.3
Zirconium	33.7

These numbers merely express the *ratios* in which the several elements combine; and hence any other numbers denoting the same ratios would be equally accurate. This being the case, it is necessary to assume the equivalent number

of some substance, and to deduce the other numbers directly or indirectly from it. In the above table, the equivalent number of hydrogen is assumed, and fixed at unity, and from it all the others are deduced. Some chemists assume the equivalent of oxygen, and call it either one, or one hundred, which changes all the hydrogen numbers proportionably; but the hydrogen unit is more convenient, and more generally adopted. At one time it was maintained that the equivalent numbers were not merely expressive of definite ratios; but that all the larger equivalents contained the smallest, or that of hydrogen, an even number of times; that is, were exact multiples of its equivalent. When this multiple relation of the equivalents was admitted, it is easy to perceive that the assumption of unity to denote hydrogen caused all the other elements to be represented by whole numbers. This rendered the numbers expressive of combining weights or atoms exceedingly simple; but unfortunately the multiple relation here referred to has been proved to be unfounded. Hence it is that most of the substances in the above table are expressed by decimals, notwithstanding the hydrogen unit is adopted. It may be here remarked that the disproof of this multiple property of the equivalent numbers, in relation to that of hydrogen, does not interfere in the least with the validity of the various arguments which support the atomic theory.

Although chemists are unanimous in adopting the atomic theory as a truth, they are by no means agreed, in all cases, as to the number of atoms which the combining ratios represent. Thus Berzelius admits that hydrogen unites with chlorine in the ratio of 1 to 35.42, but he conceives that these two numbers represent severally two atoms of each of the elements in question, oxygen being called 8. Again, this chemist admits the ratio of 1 to 8 in the combination of hydrogen and oxygen to form water; but his theoretical view is that the 1 represents two atoms of hydrogen, while the 8 denotes but one atom of oxygen. These observations are made to show that the equivalent ratios do not always coincide with the atomic ratios, as adopted by particular chemists. The nature of this work precludes any explanation of the theoretical grounds on which certain chemists have rested, in adopting atomic ratios different from the equivalent ratios. It may be remarked, however, that to deny that the experimental ratios form a true representation of single atoms of the combining substances on *slight* theoretical grounds, and to suppose that these ratios represent in fact several atoms of the different substances which unite, has the effect of creating confusion; as it gives rise to variations in the atomic numbers, according to the notions of different chemists, who nevertheless may not differ in the least in their analytical results.

Franklin Bache.

ATONY. (From α priv. and τονος, strength.) Deficiency of tonicity—relaxation, or a diminution or loss of the elasticity of the tissues. (See *Tonicity*, and *Debility*.) I. H.

ATONIC. Appertaining to atony. I. H.

ATRABILIARY. An epithet given to the melancholic and hypochondriac, by the ancients, because they believed that the *Atrabilis* (q. v.) predominated in such persons. I. H.

ATRABILIS. (From *atra*, black, and *bilis*, bile.) Black bile. The ancients gave this name to a thick, black, acrid humour, secreted, according to some, by the pancreas, and to others, by the suprarenal capsules. To the influence of this humour many diseases were attributed, especially melancholy, hypochondriasis, and insanity. It is almost unnecessary to state, that the existence of such a fluid is entirely hypothetical; and that what was termed atrabilis, is the bile itself, which in some diseases acquires a black colour and irritating properties. I. H.

ATRESIA. (From α priv. and τρητος, tube.) Without an opening. *Imperforate*. (See this last word.) I. H.

ATROPA. (*Mat. Med.* and *Bot.*)

Sex. Syst. Pentandria monogynia. *Nat. Ord.* Solaneæ.

Gen. Ch. *Corol.* bell-form. *Stam.* distant. *Berry* globular, two-celled. Eaton.

The genus Atropa consists of but few species, which are eminently distinguished for their acro-narcotic properties, more especially the *A. belladonna* and *A. mandragora*. They are generally herbaceous perennials, growing in rich soil and damp situations, and peculiar to temperate climates; Descourtilz, however, describes an arborescent species found in the West Indies, and which he states is possessed of so much activity as to paralyze the tongue on merely chewing a leaf of it. (*Flor. Med. des Antill.* III. 119.)

A. belladonna. Deadly nightshade. *Belladonne*, Fr.; *Wolfskirscher*, Germ.

Sp. Ch. Stem herbaceous; leaves ovate, undivided. Linnæus.

The deadly nightshade is a herbaceous perennial, indigenous to many parts of Europe and probably to some districts in Asia, since Ainslie (*Mat. Ind.* I. 246.) states that it is well known in the Mogul country and to the Arabians and Persians; but adds that he has never seen it in India. It is usually found in situations where the soil is rank, as in churchyards, and on dunghills. It has a thick, succulent root, giving rise to one or more erect, round, purplish, annual stems, attaining a height of about three feet. The radical leaves are sometimes very large; those of the stem are alternate, ovate, entire, of a dusky green colour above, paler beneath. The flowers are large, nodding, solitary, axillary; the corolla is of a dusky red colour, and has a narcotic smell. The berry is large, roundish, at first green, but when ripe, becoming of a shining black or dark purple colour, containing many seeds, and a violet-coloured juice, which is said to impart a rich and permanent stain to paper, so as to form a good pigment.

Every part of the plant is poisonous, producing all the symptoms of the most energetic acro-narcotics. The leaves are the only portion recognized as officinal. These are principally imported in a dried state from Europe, though of late years the plant has been extensively cultivated for medical purposes in various parts of the United States, and more especially by the Shakers; but whether from want of due attention in drying the leaves, or from the effects of cultivation, it has not proved as efficient as the imported article.

Although the deadly nightshade acts so energetically on man, it is eaten with impunity by several animals, as the sheep, the hog, and the rabbit, affording additional proof that the effects produced by poisonous agents on the inferior races, ought not to be considered as a criterion of their action on man. (See *Belladonna.*)

A. mandragora. Mandrake. *Mandragore*, Fr.; *Abraun tollkraut*, Germ.

Sp. Ch. Stemless, scapes one-flowered. Linnæus.

The mandrake is a native of the southern parts of Europe, growing in secluded situations where the soil is rich and damp. The root somewhat resembles a parsnep, but is generally bifurcated, and from two to three feet long. It was formerly in high repute as a narcotic, but is now seldom or never used, though there is every reason to believe that it possesses all the qualities of the belladonna in an increased degree. R. E. Griffith.

ATROPIA. *Atropium. Atropine.*—These names have been given to an alkaline substance detected by Brandes, in 1819, in the leaves of the belladonna; but his experiments not having been confirmed for many years, chemists became doubtful of the existence of this body, until the investigations of Geiger and Hesse on the one hand, and of Mein on the other, demonstrated the validity of the discovery. It should be mentioned, however, that Pauquy says he extracted it from the root of the same plant in 1825, and also states that he procured it from the stems of the datura, the hyoscyamus, &c. This evidently proves that the substance obtained by him could not have been pure atropia, but was in all probability the salts of some of the mineral alkalies. Dr. Runge (*Ann. de Chim.* XXVII. 32.) likewise indicated a new method of obtaining it a few years afterwards, as did also Tilloy (*Journ. de Pharm.* XIV. 658.): the process of this latter chemist is, however, very defective, and affords an impure product, though it possesses considerable activity, for when less than a grain is dissolved in an ounce of alcohol, a few drops of the solution will sensibly dilate the pupil of the eye. Ranque and Simonin have asserted (*Journ. Gén. de Méd.* No. 103. p. 36.) that this alkali exists in the ethereal tincture of belladonna, but this fact is denied by Boullay and Henry. (*Journ. de Pharm.* XIV. 255.)

Pure atropia is in white prismatic crystals, inodorous, soluble in absolute alcohol and sulphuric ether. Water at ordinary temperatures dissolves only about $\frac{1}{500}$, but takes up a much larger portion when aided by heat. This solution has a disagreeably bitter taste, and even when extremely diluted will act powerfully on the iris, dilating it very promptly and durably. It is not volatilized at the temperature of boiling water, but on an increase of heat, melts and is transformed into empyreumatic fumes. It forms definite salts with the acids, the most readily crystallizable of which are the sulphate and acetate. Atropia is slowly acted upon by water and the atmosphere at ordinary temperatures, losing its property of crystallizing. The solution assumes a yellowish colour, and furnishes an uncrystallizable residue, soluble in water in all proportions, and having a nauseous narcotic odour: it however is not deprived of its poisonous properties, and is still capable of forming crystalline compounds with the acids.

The best process for its preparation is that of MEIN. (*Journ. de Pharm.* XX. 87.) This, besides affording a pure product, is more simple than the others. Twenty-four parts of dry roots of belladonna, obtained from plants of two or three years of age, are to be reduced to an extremely fine powder; this is to be digested in sixty parts alcohol 86° to 90°, for several days, then subjected to pressure, and again treated with the same proportion of alcohol as before. These tinctures are to be united, filtered and mixed with one part powdered lime, and the mixture frequently shaken during twenty-four hours. After being again filtered, diluted sulphuric acid is to be added drop by drop, until in slight excess, to precipitate the lime, which is to be removed by filtration. The tincture is then to be distilled till one half has passed over, and the residue diluted with six parts of distilled water, and evaporated in a capsule by a gentle heat till it is reduced to one third. After cooling, a concentrated solution of potash is to be very gradually added, as long as there is any turbidness. After any precipitate is removed by filtering, the mixture is suffered to stand, when it will present a gelatinous mass containing white crystals of atropia. The fluid mother-waters are to be decanted, and the residue compressed between folds of blotting-paper. The impure atropia thus obtained is to be dissolved in five times its weight of pure alcohol, the solution filtered, and six times its bulk of distilled water added. In about twenty-four hours, crystals of atropia of a bright yellow colour will be deposited: these are to be washed with a small portion of water, dried, and again treated as above, when the pure article will be afforded. Twelve ounces of the dried root afford about twenty grains of pure atropia.

RUNGE has also prepared this alkaloid from the extract, by pouring on a solution of sulp. magnesia sufficient of a solution of potash to decompose the sulphate, and thus forming a hydrate of magnesia mixed with sulphates of potash and magnesia: to this, extract of belladonna is added, and the whole evaporated to dryness, reduced to powder, and treated with boiling alcohol. On spontaneous evaporation, crystals of atropia were obtained.

Atropia or its salts have seldom been employed, though from their activity and the certainty of their action, they would form an advantageous substitute for the extract of belladonna, which is seldom to be depended upon, from deficient preparation, or the effects of age. Dr. REISINGER states that they are superior to the extract, in acting as direct sedatives, whilst the primary effect of the extract is stimulant.

R. E. GRIFFITH.

ATROPHY. *Atrophia.* (From α priv. and τροφη or τρεφη, nutrition.) Defective nutrition. More properly, *Oligotrophy.* (From ολιγος, little, and τροφη, diminished nutrition.)

By some pathologists, the term atrophy has been restricted in its application to a defect of nutrition, or wasting, merely local, or confined to one or more parts of the body; the condition in which there is a general wasting or diminution of the volume of the organic solids, dependent upon some serious disease influencing the nutritive functions, being designated by the terms *emaciation*, *marasmus*, &c. In an anatomical and physiological sense, this distinction is inadmissible, since atrophy, as it has been defined, may be either local or general—affecting one or more of the tissues, or implicating the entire assemblage of them at the same time.

The animal tissues are developed and sustained by the introduction of nutritive molecules, which are derived from the aliments, and so modified by the vital powers of the organs, as to adapt them to the nourishment and growth of the body. This is effected by the conjoint agency of the nutritive functions, and the materials thus elaborated are regularly deposited in the meshes of the tissues, there to remain for a limited period, and then to be absorbed into the circulation, from which they are either thrown off as effete matter, or after undergoing further changes, are again appropriated to the purposes of nutrition. Any cause disturbing the equilibrium and order of these functions, will derange the process of nutrition, and if such disturbance be of a character to withhold or abstract the usual supply of nutritive elements from one or more tissues or organs, the result will be, a corresponding degree of atrophy, or diminution of the volume of the part or parts affected.

Atrophy presents itself under a great variety of modifications, dependent upon the number and extent of the parts involved, their importance in the economy, and the period of life at which the derangement takes place. The causes capable of inducing it are also multifarious; yet they all operate by influencing either the function of assimilation or that of absorption—in the one case interrupting the deposition of the proper quantity of nu-

tritive materials, and in the other occasioning their too rapid removal from the situations they should occupy. A disturbance of these vital acts may occur either during the fœtal or independent stages of existence, giving rise in the first case to imperfect and anomalous developments, and in the second, to a diminution or preternatural wasting of the mass of the organized solids. We shall notice, successively, the principal modifications of the organs which give rise to atrophy.

1. *Congenital defect of the formative or plastic energies.* The animal organization, in its evolution, passes through several types and degrees of development before it attains the perfect form and arrangement destined to represent its permanent condition. The operation of the formative energies may be suspended or enfeebled at any one of these stages of development, and as this will give rise to an interruption of the evolution of the organs affected, their growth will be suspended, and at the period of birth, they will exhibit the imperfect type which they bore when the plastic forces were disturbed. This law is exemplified in various forms of congenital atrophy, as, the imperfect development of the whole or a part of the extremities; defective evolution of the kidneys and supra-renal capsules, spleen, brain, and other organs. Under different degrees, it is the source of a large proportion of the vices of conformation which are observed in the animal organization, and under a still greater extent, it gives rise to all the monstrosities from defective evolution.

In many cases, there seems to exist an intimate relationship between the development of the nervous centres and certain forms of congenital atrophy. Ferrus remarks (*Dict. de Méd.* 2d edit. IV. 369.) that amongst the great number of wretched inmates of the Hospices Bicétre and Salpétriére, who are degraded by a state of idiotcy or mental imbecility below the level of their species, a state of atrophy and general paralysis is of frequent occurrence. A series of dissections prosecuted, first by Amussat, afterwards by Scipio Pinel, revealed almost constantly a dependence of the various forms of congenital atrophy upon some notable alteration of the different portions of the nervous apparatus. In many cases the brain was imperfectly developed—the convolutions effaced, and the substance of the organ indurated. Sometimes a compact mass or nucleus was surrounded by a portion of the brain in a soft diffluent condition. The medullary substance predominated, and when an organ on one side of the body was atrophied, the hemisphere of the opposite side of the brain was reduced to nearly one third its ordinary size. It is likewise stated by Rostan (*Cours de Méd. Clinique*, &c. II. 122. Paris, 1830.) that in idiots affected with congenital atrophy of the extremities, the brain always presents manifest indications of destruction on the opposite side. To these facts may be added the assertion of Serres (*Anatomie comparée du cerveau.* II. 125.) that there is a perfect correspondence between the evolution of the cervical and caudal protuberances of the spinal marrow, and the development of the upper and lower extremities. This correlation is, however, far from being constant. A defective evolution, or an entire absence of the nervous centres, does not necessarily involve the extremities in a state of congenital atrophy. Facts in sufficient number have been collected, in which the organs, together with the nervous chords which supply them, were perfectly formed, notwithstanding the corresponding portions of the nervous centres were imperfectly evolved, or totally absent. (See *Acephalus*, and *Anencephalus.*) A very interesting illustration of this law has been published by Lallemand. (*Observat. Path.*, &c. Paris, 1825.) The subject of it was an anencephalous monster, with entire absence of the spinal marrow, in which, notwithstanding this defect, there was no coexisting atrophy of the limbs.

2. *Inadequate supply of blood, or deterioration of the properties of that fluid.* If the opinion of Serres and Geoffroy St. Hilaire, that the evolution of the organs in the fœtal state, proceeds in a strict ratio with their supply of blood, be still regarded in the light of a mere hypothesis, it must be admitted that atrophy is very often induced by an inadequate supply of nutritive fluid, or an alteration, more or less considerable, of its qualities. The causes cutting off this supply may act either partially or generally. Amongst them, may be enumerated constriction or obliteration of the main artery of an organ, an impediment to the free passage of the blood through it occasioned by the pressure of a tumour, thickening and induration of the surrounding parts, extensive ossification and other organic lesions of the coats of an artery, a general state of anemia, whether it proceed from excessive losses of blood by hemorrhage or otherwise, or a general consumption of

that fluid, as in phthisis pulmonalis and other chronic diseases;—finally, a privation of aliment, the use of such as is not fit for the purposes of nutrition, and some defect of the digestive and assimilative organs, inducing imperfect chylosis, perverted hematosis, and a consequent incomplete assimilation of the nutritive fluids.

Preternatural constriction or narrowing of the principal artery leading to an organ, by interfering with the proper supply of blood, gives rise to atrophy of the part thus affected. In a case of this kind mentioned by Townsend (*Cyc. of Pract. Med.* I. 214.) the kidney was reduced to one half its size by a diminution of the calibre of the emulgent artery; and he cites another example, on the authority of Lobstein, in which the spleen was atrophied to the size of a filbert, the splenic artery itself being so small as scarcely to admit a bristle. The influence resulting from the application of ligatures to arteries illustrates the same principle. Under such circumstances, atrophy of the parts furnished by the tied artery ensues, unless an adequate supply of blood is furnished by the collateral vessels. Upon the same principle, we occasionally resort to the ligature with the view of obtaining atrophy of an aneurism, of fungous tumours of the antrum and eye, and of enlargement of the thyroid gland; the obliteration of the main arteries leading to these parts by ligature, being often sufficient to occasion the morbid growth to collapse, shrivel, and occasionally disappear altogether. The influence of long-continued pressure is well known. It may occasion atrophy either by interrupting the transit of the blood through the main artery, or by prohibiting its entrance into the capillary vessels of the organ. The extreme rigidity of the arteries in old age, often so far disqualifies them for the performance of their function, that they are unable to transmit a sufficient supply of blood to maintain the healthy nutritive functions. Extreme atrophy of the members is a very frequent consequence of this defective circulation, and occasionally this process advances so far as to destroy the vitality of the part, as is exemplified in dry gangrene. A very notable degree of atrophy of the muscles is often induced by long repose, or a sedentary inactive habit, which, by diminishing the supply of blood, impairs the nutritive acts of those organs;—and in tabes mesenterica, phthisis pulmonalis, and other chronic diseases giving rise to defective chylosis and hematosis, or producing inordinate losses of the nutritive fluids, such an extreme degree of atrophy is sometimes developed, as to reduce the individual to the condition of a walking skeleton. Portal, indeed, has asserted, that in those who die of phthisis by gradual but protracted wasting, the blood is almost entirely consumed. (*Traité de la Phthisie Pulmonaire.* p. 334.) Finally, atrophy may be occasioned by imperfect sanguification, either as a consequence of an inadequate formation of blood, or such a deterioration of the properties of that fluid, as to render it unfit to maintain the integrity of the nutritive function. (See *Blood, diseases of. Marasmus. Emaciation*, &c.)

3. *Impaired Innervation.* Of all the causes of atrophy, a diminution or suspension of innervation probably exercises the greatest influence. This is well exemplified in the wasting of paralytic limbs consequent upon injury of the brain, spinal marrow, or nerves. It is probable, however, that there is some difference as regards the manner in which the atrophy is produced, according as the defect involves the cerebro-spinal, or the ganglionic portions of the nervous system. When the latter is affected, we are inclined to think with Copland, that the wasting is in all cases direct; but when the defect involves the cerebro-spinal nerves, it is probable, that, in some cases at least, the atrophy is indirect, and merely ensues in consequence of the inactivity of the muscles, which naturally tends to diminish the determination of blood to them, as exercise always produces a contrary effect. This difference results from the more intimate relationship of the ganglionic nerves with the capillary vessels, their controlling influence being indispensable to maintain and regulate those molecular changes of the nutritive fluids, which are immediately concerned in nutrition. The cerebro-spinal nerves being more directly employed in the functions of relation, while they influence more or less the acts engaged in the support of the individual, their participation in the latter class of functions is far more limited than that of the other nerves.

There seems to be a notable difference, as regards the period at which atrophy ensues, after injuries of the several portions of the nervous system. This difference is particularly conspicuous between lesions of the brain and those of the individual nerves. Under the latter circumstances, Townsend has correctly remarked, that the wasting supervenes rapidly,

whereas after injuries and diseases of the brain, it is more tardy in making its appearance. (*Cyc. of Pract. Med.* I. 214.) We have seen the truth of this remark exemplified in several instances. In an individual who received a severe contusion of the lower part of the spine and the buttocks, in falling from the mast of a ship, the muscles supplied by the sacro-sciatic nerve became paralyzed, and wasted rapidly; and in a gentleman who had the lumbar plexus of nerves wounded in a duel, the muscles of the corresponding limb were reduced to one half their natural size in a short time. In dislocations at the shoulder joint, the elbow, knee, &c., when the displacement is not reduced, and the head of the bone is allowed to press on the adjacent nerves, considerable atrophy often ensues; and a similar consequence frequently follows distortion of the limbs from rheumatic inflammation and other causes. Sir Charles Bell has reported two cases of atrophy produced by a local disease of a nerve. In one, the muscles and ball of the thumb were so much wasted, that the bones, and the strings of the tendons over them, might be felt quite plainly; and in the other, while the forearm was firm to the feel, the muscles of the arm were wasted and loose, so as to render all the processes of the humerus, from the shoulder to the elbow, quite distinct, and the deltoid was also quite gone. (*Append. to the Nat. Syst. of Nerves.* American edit. p. 221.)

Atrophy succeeding an injury of a nerve sometimes continues through life. In an individual who died at the age of fifty-four, and who during childhood had received a oontusion of the crural and sciatic nerves, Lobstein found all the parts of the paralyzed limb—even the bones—reduced to an extreme state of atrophy. The right femur weighed only three ounces two drachms and a half, while the weight of the left was nearly double. The gastrocnemius and soleus muscles of the sound limb weighed eight ounces—those of the atrophied member only two ounces six drachms. (*Traité d'Anat. Path.* I. 91.) Townsend mentions the case of a child, whose wrist remained perfectly useless and reduced to one half its proper size, by a sprain which was neglected at the time it was received.

Notwithstanding the frequency with which atrophy supervenes upon diseases and injuries of the brain, such a result is far from being constant. In several of the old and infirm paupers affected with paralysis, inmates of the Dublin House of Industry, Townsend remarks that he found the wasting of the paralyzed limbs inconsiderable—and scarcely greater than would have occurred if the muscles had been voluntarily kept in a state of inaction for the same length of time. The observations, however, of Amussat, Pinel, and Serres, already referred to, prove that the influence of the brain over the acts of nutrition is very great; and it is remarked by Lobstein, that in some cases of general emaciation, the only organic lesions he could discover, on opening the body, were, a tuberculous induration of the brain, or a development of a fibrous mass within its substance. A similar condition of that organ was discovered by Tessier and Esquirol, in several epileptics affected with atrophy. To the same category of phenomena, may be referred the paralysis and consequent atrophy which sometimes attack those exposed to the influence of lead. But whether the wasting proceeds from the one or the other of these causes, it should be borne in mind, that it may be either direct or indirect. It may result from the suspension or annihilation of that influence which the nerves exercise over the molecular changes of the tissues, in virtue of their intimate association with the capillary vessels, or it may be merely a consequence of the suspension of volition and muscular contraction, the effect of which is to diminish the determination of blood to the part, and thereby diminish its nutrition.

4. *Suspension of the Function of an Organ.* The full round and vigorous muscle of those who are engaged in laborious avocations, has often been a subject of remark:—the opposite condition of these and other organs, in individuals who lead a sedentary life, or who consign themselves to a comparative state of inactivity, is not less conspicuous. The full employment of an organ is indispensable to ensure the perfect development of its vital powers; constant exercise being a condition required to produce that influx of nutritive elements and nervous influence, upon which its powers depend. Whenever this state of activity is exchanged for one of repose, the organ being divested of its due supply of vital stimulus, no longer attracts to itself the usual quantity of blood and nervous influence; its nutritive acts become impaired; and it falls into a state of atrophy. The nutritive fluids, therefore, being diverted into other channels, the vessels of the affected organ undergo a notable diminution

of size, and these changes may even advance so far as to give rise to a total obliteration of many of the arterial ramifications, or even of the trunks themselves, precisely as takes place in the obliteration of the umbilical arteries and the ductus arteriosus of the fœtus after birth. Almost every period of existence affords exemplifications of atrophy from a suspension of the function of an organ. But in some of these cases, the change should be regarded as purely physiological, since it consists in the wasting or disappearance of parts that are no longer useful, and which, if suffered to remain, would interfere with the functions of the perfected organization.

The umbilical vesicle of the ovum, which constitutes the proper rudiment of the alimentary canal, becomes useless and wastes away, at the expiration of the third or fourth month of the fœtal existence; the allantoid membrane, which forms the genito-urinary system, disappears before the whole of the organs are perfectly evolved; and in like manner, the membrana pupillaris, which during the period of fœtal life, completely separates the anterior from the posterior chamber of the aqueous humour, is destroyed before birth, so as to leave no vestige of its previous existence. Analogous changes take place after birth. At this period, the economy of the individual undergoes important modifications, in order to accommodate it to the new state of existence which it is destined to realize. The umbilical arteries and veins, the ductus arteriosus, and the ductus venosus, being no longer an essential part of the circulatory apparatus, contract upon themselves, become impervious, and in the end fall into such a complete state of atrophy, that their remains are rendered almost imperceptible. The left lobe of the liver, moreover, the supra-renal capsules, and the thymus gland, all remarkably voluminous in relation to the other organs during the period of fœtal life, now undergo a notable diminution of volume, and some of them even disappear entirely in the adult age. Similar changes are observed in those animals which at a certain period of life are submitted to a process of metamorphosis, to adapt their organs to the new modifications of action which are necessary in their economy. The several species of caterpillar, after they have maintained that form for a definite time, undergo a process of atrophy, by which a portion of their body is destroyed, while from the remaining portion, the living animal escapes under a new mode of existence, denominated pupa or chrysalis. The tadpole, also, which at first possesses all the economy of a fish, when it has attained a certain degree of development, has its gills and tail annihilated by gradual atrophy, and assumes the type and all the attributes of a perfect animal of its own species.

Many examples of a similar character are presented by the changes which the organs undergo at subsequent periods of life, some of which are the result of a suspension of function, while others are attributed to modifications of the vital acts enfeebling nutrition. As old age approaches, the energy of the heart's action is abated, and the walls of that organ become atrophied; the muscles contract feebly, and we often find them reduced to mere shreds. The bronchial tissues, according to Andral (*Précis d'Anat. Path.* I. 185.), sometimes become so much diminished in size, that the pulmonary air-cells are singularly rarefied and enlarged, and exhibit an arrangement similar to that of the lungs of reptiles. The testicles in advanced life are often absorbed and converted into mere nuclei; the ovaries and mammæ become contracted and shrivelled; and the thyroid and lymphatic glands frequently have their volume very remarkably diminished. We have seen both testicles so greatly atrophied in an old man, that one of them was not larger than a common bean, while the other had entirely disappeared, leaving nothing but a mere rudiment of the fibrous coat, and the tunica vaginalis filled with water It is remarked by Ribes (*Bulletin de la Facult. de Méd.* VI. 299.), that in old age, the corpora cavernosa penis become larger, and the membranous partitions which intersect them, are so attenuated, or removed by absorption, that quicksilver traverses them with great facility. The form and volume of even the bones are sometimes altered by atrophy:—the long bones especially become more slender; the neck of the femur is shortened and has its direction changed; the alveolæ of the jaws are wasted away, and the obliquity of the ascending branches of the inferior maxillary bone is increased. The length of the vertebral column is diminished; and the cranial bones, according to the observations of Tenon (*Mém. de l'Institut.* I. 221.), lose one fifth their weight. In some cases, indeed, the articular cartilages are partially or entirely removed by atrophy, so as to suffer the heads of the bones to rest in immediate contact with each other;

and it has been remarked by DESMOULINS, that in old age, both the nervous chords and their ramifications have a volume manifestly inferior to that of the same parts in early life, and that the mass of the brain, under the same circumstances, is less by one fifth. (*Journ. de Physique*, *l. c.* 442. LOBSTEIN.) He hence infers that the diminution of this organ involves that of the cranium also, inasmuch as the latter subsides to accommodate itself to the former. It may be remarked, moreover, that when an eye becomes unfitted for the office of vision, it undergoes a marked diminution of volume; and a case is reported by ANDRAL, on the authority of RENAUD, which indicates very clearly the influence of the suspension of the function of an organ in producing atrophy. One of the bronchial tubes of a monkey was nearly closed by a large lymphatic ganglion filled with tuberculous matter, and the corresponding lung was so much atrophied, that the walls of the thorax on that side were contracted, as in chronic pleurisy after the effused fluid has been absorbed.

5. *Inflammation, and augmented nutrition of adjacent tissues.* It may appear strange to affirm, that increased irritation of a tissue sometimes occasions a diminution of its volume; yet several circumstances demonstrate that such is the fact. It often happens when a part is irritated to a degree considerably beyond that which is compatible with the healthful exercise of its function, that its nutritive powers are impaired, or so perverted, as to give rise to a considerable modification of its volume. Whether this depend upon an inability on the part of the capillary vessels of the organ to attract an adequate supply of blood, an incapacity of the vessels to impress upon that fluid the changes requisite in the process of assimilation resulting from an impairment of their energies, an obliteration of the capillaries themselves by inflammation, or an inordinate activity of the process of interstitial absorption, by which the nutritive molecules are displaced more rapidly than they can be supplied, is difficult to decide. Certain it is, that atrophy from inflammation is of frequent occurrence, and there are many reasons for suspecting, that all the causes mentioned may co-operate in producing the same result. It is seen in the atrophy of the muscles from rheumatism, and especially in glands which have been for a long time affected with chronic inflammation. It is strikingly exemplified in the condition denominated *nutmeg liver;* and the spleen, kidneys, and pancreas, often exhibit a similar diminution of volume, as a consequence of chronic inflammation. Many cases of atrophy, however, are only indirectly dependent on inflammation, and must be explained by that law, in virtue of which, a preternatural augmentation of the vital acts of one tissue, is accompanied with a corresponding diminution of the activity of some other. Numerous exemplifications of this principle might be cited. Under the preternatural irritation of the organs attendant on chronic diseases, the adipose tissue disappears almost entirely; the muscles become small and flaccid; the angles of the bones salient; the cellular tissue collapsed, as it were, into their interstices; the membranes attenuated; and the weight and volume of the soft parts are sensibly diminished. Inflammation of the mucous membrane of the stomach and intestines is often attended with atrophy of the muscular coat; a disease of one kidney sometimes gives rise to a wasting of the other; and in diseases of the articulations, the intense irritation which implicates their structures, occasions so much wasting of the surrounding parts, as to expose the projecting angles of the bones. In many cases, moreover, of protracted disease of the liver, the spleen is found notably atrophied; and it has been suggested by ANDRAL, that the condition of the liver, to which LAENNEC has applied the appellation of *cirrhosis*, is merely owing to an atrophy of the dark, and hypertrophy of the yellow or medullary granules of that organ. We have often observed a similar concurrence of the two modifications of nutrition in the cortical and tubular structures of the kidneys, as well as in the fibrous and vasculo-glandular tissues of the spleen. It likewise often happens, that while the interstitial cellular tissue of an organ becomes greatly hypertrophied, the other textures composing the part affected are nearly displaced by atrophy. This is particularly manifest in the several glands, and in the hollow organs; as the alimentary canal, bladder, &c. All these consequences result from a portion of that energy which is necessary to sustain the nutritive actions of the tissues being diverted from one or more of them, to be consumed upon others more intensely irritated.

It will be proper in this place to mention another modification of atrophy, in which the natural textures of an organ are wasted, and have their place supplied

by a preternatural generation of fat. This is more particularly manifested in the muscular and glandular organs. In some cases in which the muscular fibres are almost annihilated by atrophy, their interstices become so filled with adeps, that no diminution of volume can be perceived. There seems, indeed, to be a certain correlationship between the atrophy of an organ and the inordinate development of adipose substance; for it very often happens, when a part falls into this state, that it is completely surrounded by fat. This coexistence is frequently observed in the heart, the kidneys, testicles, and several other organs, when their substance is wasted by atrophy. Andral, by whom this fact has been particularly noted, has suggested that the atrophy of an organ should be rather regarded as a kind of *retrogradation* of the process of nutrition, than a diminution or suspension of its activity. This hypothesis, however, is altogether inadmissible, inasmuch as the coincidence in question, though of frequent occurrence, is by no means constant. It is not unusual for the same preternatural accumulation of adipose substance to take place, when the corresponding organ is in a state of hypertrophy. This we have repeatedly observed in cases of hypertrophy of the heart, and the coats of the large intestines; and it has been very correctly remarked by Bouillaud (*Dict. de Méd. et de Chirurg. Prat.* III. 632. Paris, 1829.), that the colon is often included in fat, at the same time that its tunics are greatly increased in thickness.

6. *Preternatural activity of the process of absorption.* It was long since supposed by Cruickshank, that the absorbent vessels, by having their activity increased in a ratio disproportionate to that of the assimilative powers, remove the substance of the tissues, and thus produce a diminution of their volume. A similar view was also entertained by Hunter, who regarded these vessels as the modelers of the organic solids. The investigations of modern pathologists have rendered it probable, that the lymphatics, in common with the veins, are merely instruments for the transmission of the absorbed fluids, and that the act of absorption is performed by the tissues themselves. It is at least highly probable, that this, like other vital or organic acts, may be preternaturally increased under particular circumstances; and if this be admitted, it must be apparent, that whenever such increase of the process of absorption transcends the measure of assimilation, or of the deposite of nutritive molecules in the substance of the tissues, more or less atrophy will be the consequence. It is possible, indeed, that some of the cases of what has been styled general atrophy, may depend upon this cause; for we sometimes find this condition existing when the most careful examinations after death do not reveal any material derangement of important organs which could lead to such a consequence. The known effects of iodine, and some other agents, in promoting the absorption of the testes and mammæ, as well as the power of mercury to occasion the disappearance of certain morbid products, are favourable to the justness of such an inference.

The condition of the organs affected with atrophy varies greatly as regards their form and volume—their texture, and the relations of their several constituent parts to each other. In some cases there is simple but manifest wasting, amounting to an absolute diminution of volume; as, for example, in atrophy of the muscles, and many glands—in the adipose, cellular, and other tissues; and in some instances, even in the hollow organs. The last, however, frequently undergo a great degree of atrophy, without their configuration or volume being at all changed. Under these circumstances, there is a considerable abstraction from the mass of the constituent molecules; but the cavities of the organs are either augmented, or their tissues are so much rarefied, that no manifest decrease of volume can be perceived, notwithstanding they may have lost one third their ordinary weight. This condition is often observed in atrophy of the heart, alimentary canal, uterus, bladder, &c., the walls of which are sometimes so much attenuated by a diminution or disturbance of their nutritive energies, as to give rise to a complete perforation, or such a degree of attenuation, as to render them liable to be ruptured by the natural degree of distension to which they are exposed in the performance of their functions.

An organ may also be extensively atrophied, yet undergo no diminution either of weight or volume. This occurs in organs composed of two or more tissues; as, for example, the liver, kidneys, spleen, &c. Under these circumstances, while one of the constituent elements undergoes a process of atrophy, the others become hypertrophied;—the accumulation of nutritive molecules in the one, compensating for their diminution in the other. Besides this condition, there is another, in which

the weight is diminished, but the volume remains unchanged. Some of the examples of atrophy of the hollow organs, already referred to, are of this kind, and other exemplifications are occasionally furnished by the bones. The compact substance of these structures is frequently so much attenuated, as scarcely to equal one or two leaves of paper in thickness (LOBSTEIN. *Op. Cit.* I. 63.), and the preternatural fragility of the cylindrical bones which is observed in certain individuals, is probably owing to a similar modification of nutrition. TOWNSEND, indeed, mentions a case, in which the femur of an adult was so much atrophied internally, that it floated on water, like cork, although its external surface presented no indication of such an alteration. (*Cyclop. of Pract. Med.* I. 212.)

When an organ is much atrophied, there is not only a diminution of its constituent molecules, but also a modification of its physical properties. It receives less blood than before; is of a paler colour; becomes shrivelled and contracted, or soft and flaccid, and deprived of its natural elasticity. Many of its smaller vascular ramifications seem indeed to become obliterated, and the whole structure is often reduced to a mere rudimentary cellular tissue, or is entirely annihilated. In a case of idiopathic atrophy affecting the whole system, which was attended with no other symptom than a general wasting of the body, HALLÉ found the lymphatic vessels obliterated, and converted into small white filaments resembling nerves; the glands were desiccated, and of a horny consistence. (*Mém. de l'Institute.* I. 536. LOBSTEIN.)

Treatment. The fact that atrophy may proceed from such a multiplicity of causes, many of them very different in their nature, sufficiently indicates, that no general system of treatment can be prescribed, which will be suited to all cases. The therapeutical indications must be deduced from the nature of the offending cause, and when that can be ascertained, such remedies should be prescribed as will be likely to remove it. In all cases of partial atrophy, the nutritive energies of the affected organ are impaired either directly or indirectly, and it should be the care of the practitioner to invigorate them either by means applied to the part when accessible, by such as act through the general system, improving the functions of digestion, chylosis, and hematosis, or by both. The local remedies must be such as will invite an increased flow of blood into the affected organ, and thereby increase its nutrition. To fulfil this end, frictions, stimulating embrocations, douches, exercise, electricity, galvanism, &c., will be indicated. The internal remedies should be specially directed to the digestive, and blood-making organs, at least in all cases where the quantity or quality of the nutritive fluids is in fault. If the defect of nutrition depend upon some organic disease, this should be overcome if practicable, and if there be merely a sluggishness of the instruments alluded to, their powers should be invigorated by a judicious course of such remedies as will tend to bring the physiological acts into full play, and thus enable them to elaborate an adequate supply of healthful nutritive fluids. In many cases, nutrition is not only enfeebled, but is greatly perverted. Under such circumstances, alteratives will be indicated—and may be advantageously combined with tonics. Small and occasional doses of the mild mercurial preparations;—of iodine, especially its combinations with iron; all the chalybeate preparations; the vegetable bitters; mineral waters; baths; exercise; travelling; nutritive diet, &c., may be enumerated as the means upon which the chief reliance must be placed; the administration being varied to suit the circumstances of individual cases. When the nervous centres are in fault, moxas, and other revellents, applied in the vicinity, may be useful; and similar applications may be made along the course of a nerve, when the atrophy depends upon a pathological state of one of those instruments.

Atrophy of the individual organs will be described in connexion with the other pathological states to which such organs are liable; and besides the treatment there indicated, reference may be made to the article *Marasmus.*

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E. GEDDINGS.

ATTENUANTS. (From *attenuare*, to make thin.) This term was formerly applied to designate an imaginary class of medicines supposed to possess the property of increasing the fluidity of the blood, by

diminishing the size of its molecules, or by dividing and separating them. The latter were also termed *incidentia* (q. v.). It is almost unnecessary to add that there are no such medicines. The only means we possess of rendering the blood more fluid is by increasing the proportion of its aqueous constituent. (See *Diluents*, *Humoralism*, &c.) I. H.

ATTITUDE. (See *Position.*)

AUDITORY. Appertaining to hearing. I. H.

AURA. A Latin word signifying air or vapour, and employed by some physicians to designate a subtile emanation or vapour arising from certain bodies. Thus the peculiar emanation given out by the spermatic fluid, and erroneously regarded by some as the fecundating principle, was termed *aura seminis*, or *a. seminalis.*; and the odour exhaled from freshly drawn blood, *aura sanguinis*. Van Helmont considered the vital principle as a gas or subtle spirit which he termed *aura vitalis*.

The word *aura* is also used to express the sensation of a kind of vapour which seems to pass from the body or limbs towards the head before an attack of epilepsy or hysteria; hence the expressions *aura epileptica* and *aura hysterica*. I. H.

AURANTIUM. (See *Citrus.*)

AURICLES. Two cavities of the heart. (See *Heart.*) I. H.

AURICULA. Diminutive of auris, an ear: the auricle of the ear. (See *Ear.*) I. H.

AURICULAR. Appertaining to the ear, particularly to the external ear. (See *Ear.*)

The little finger is sometimes termed the *auricular finger*, because, owing to its size, it can be in part introduced into the external auditory canal.

This term is also applied to denote what has reference to the auricles of the heart. I. H.

AURICULO-VENTRICULAR. Common to an auricle and ventricle of the heart. The *auriculo-ventricular openings* are those which establish the communication between the auricles and ventricles of the heart. *Auriculo-ventricular valves*, the mitral and tricuspid valves. (See *Heart.*) I. H.

AUSCULTATION. (From *auscultare*, to listen.) This term, originally introduced into medical language by Buisson, is applied to the methods resorted to for the purpose of discovering or discriminating diseases by means of signs recognized by the sense of hearing. It comprises the study of all sounds indicative of disease, in any part of the body, whether produced naturally or artificially, and whether perceived by the unassisted ear or by the aid of instruments. It is one of the means of exploration, and in many diseases a very important one, for determining, from physical signs, the diagnosis. It will be most convenient to investigate all the physical signs of disease under one head, which will accordingly be done in the article *Exploration* (q. v.). I. H.

AUTOMATIC. (From αυτοματος, spontaneous.) This term is applied to those movements which are made by the patient without any object, and apparently without the exercise of volition. They differ from convulsive movements, in the less violence of the muscular contractions which produce them, and in being easily arrested. I. H.

AUTOPSY. αυτοψια, Gr.; *Autopsia*, Lat. (From αυτος, himself, and οψις, vision.) Attentive examination by one's self. *Cadaveric autopsy;* the dissection of a dead body for the purpose of ascertaining the cause of death. (See *Necroscopy.*) I. H.

AVENA. (*Mat. Med.* and *Bot.*)

Sex. Syst. Triandria digynia. *Nat. Ord.* Gramineæ.

Gen. Ch. *Calyx* two-valved, two, three, or many-flowered. *Corol.* exterior valve lanceolate, somewhat terete, furnished with a dorsal awn. *Awn* geniculate and contorted. Nuttall.

A. sativa. Oats. *Avoine*, Fr.; *Haber*, Germ.

Sp. Ch. Panicled; *calyx* two-seeded; seeds smooth, one of them awned. Linnæus. The native country of this plant is not known, but in all probability it originally came from some part of Asia. Williamson, on the authority of Lord Anson, says that it was found in the island of Juan Fernandez: this may be the case, though its occurrence both in that place and in Sicily, where it also has been discovered in a wild state, can readily be accounted for, without considering it as indigenous. There can be no doubt that it was cultivated in Europe long before the discovery of America, and was probably known to the ancients. There are many varieties, differing in the colour of the grain and in the presence or absence of the awn. They are all very hardy plants, and flourish best in cool and damp climates; hence the oats of England and the north of Europe are much heavier and contain more farina than those of the United States. This grain, though usually

cultivated for horses, forms a very general article of food for man in the northern counties of England and Ireland, as well as in Scotland, Brittany, &c. The meal is very nutritive and easy of digestion. It has been analyzed by DAVY and VOGEL with different results: the latter found 59 starch, 4.30 albumen, 8.20 sugar, 2.50 gum, 2 fixed oil, 24 fibrous matter, as well as a bitter principle united to the saccharine matter; DAVY, in addition, obtained 6 of gluten. Other chemists have noticed an aromatic principle in the husk, having some analogy to vanilla, and which it is said can be extracted by means of water and alcohol. CHEVALLIER (*Journ. Chim. Méd.* II. 603.) is of opinion that the fecula of this grain is closely allied to arrow-root, and might be advantageously used as a substitute for it.

The grain, when deprived of its husk, is termed *groats* (*gruau*, Fr.), and in this state is directed by the British and many of the other European pharmacopœias, but is not recognized by that of the United States; the only preparation that is officinal with us is the meal.

Oatmeal, when of good quality, has a faint smell, and a very slight bitter taste. It cannot be formed into raised or fermented bread, owing to the absence of gluten, and hence is used for food in the form of cakes or gruel. The latter preparation affords a light but nutritive aliment, particularly adapted where a strict antiphlogistic regimen is necessary. As generally made, however, from its thick, turbid appearance, it is often extremely unpleasant to patients: as directed to be made by CULLEN, the nutritive portions of the meal are obtained without this disadvantage. He orders an ounce of meal to three quarts of water, to be placed on the fire and stirred till it boils; the ebullition is continued until about a third of the water is evaporated. It is then strained and suffered to stand, till, on cooling, a sediment is deposited, when the clear part is poured off for use. When admissible, sugar and lemon-juice are added to improve the flavour, but the most usual addition is that of raisins. Oatmeal gruel is slightly laxative in most cases, and in some persons even acts with some energy on the bowels. It is sometimes used as an enema, and the meal made into a thick paste with hot water forms a favourite emollient cataplasm with some practitioners. (See *Diet*, *Regimen*, &c.)

R. E. GRIFFITH.

AVENS ROOT. (See *Geum.*)

AXILLA. By the term axilla or arm-pit, is generally understood the triangular excavation included between the upper part of the arm, the shoulder, and the side of the thorax. In considering the surgical anatomy of the axillary region, it is necessary to define its boundaries more accurately, and to include parts within it that are not comprised under the common acceptation of the term *arm-pit* applied to this part.

ART. I. SURGICAL ANATOMY. The axillary region, viewed in its full extent, is of a triangular shape, comprising all that part of the upper portion of the arm occupied by the attachment of the pectoralis major and latissimus dorsi, and the corresponding surface of the thorax. The space circumscribed by these limits, represents a triangular pyramid, obliquely inclined, the apex of which ranges upwards between the clavicle, the scapula, and the first rib, where it becomes continuous with the cervical region, while the base is downwards, and is formed by the skin stretched across the hollow of the arm-pit. The other boundaries of the region are the pectoralis major and minor, in front; the subscapularis, teres major, and latissimus dorsi, behind; and the surface of the ribs, covered by the serratus magnus, internally. The superior external boundary, which is very narrow, is formed by the shoulder joint, together with the adjacent portion of the humerus.

The height of the axillary region is greater in the male than in the female; but its dimensions vary, according to the position of the arm. When the member is forcibly elevated from the side, so as to put the pectoral muscle upon the stretch, the anterior face of the region presents nearly a plane surface, having, nevertheless, a slight prominence along its upper border, formed by the clavicle (*Fig.* 1. A.), and at its upper and outer portion, a considerable hollow, especially in lean subjects, corresponding to the external extremity of the clavicle, and the adjacent portion of the deltoid muscle. In this situation, a small triangular space can be distinguished by the touch, bounded internally by the coracoid process (*Fig.* 2. *a.*), superiorly by the acromian, and externally by the head of the humerus. The point of the catlin is plunged through the centre of this space, in amputating at the shoulder joint, according to one of the methods prescribed. (See *Shoulder.*) The base of the axillary region presents a deep excavation, bounded in front and behind by the folds formed by the pectoralis major and latissimus dorsi muscles. When

the arm is but slightly drawn from the body, this excavation is deep; but when the member is elevated to a perpendicular direction, the cavity is nearly effaced; the head of the humerus being forced downwards, so as to render the surface somewhat convex by protruding the skin before it.

The *skin* occupying the anterior face of the axillary region, presents nothing worth noting. That, however, which is folded into the arm-pit, is remarkable for its softness, for the hair which springs from its surface, its great number of sebaceous follicles, and the peculiar odoriferous secretion which it pours out. These characters render it very susceptible of disease, and its follicles, in particular, frequently inflame, and undergo various morbid changes.

The cellular tissue, with its adipose substance, forms a stratum, of variable thickness in different individuals, between the skin and the deeper-seated parts. Its most superficial portion is somewhat loose and filamentous, and is traversed by small vessels, and nervous filaments from the cervical plexus. Near the clavicle, some of the fibres of the platysma myoides muscle are besides spread out in its substance. The deeper-seated part, which reposes upon the pectoral muscle, is more compact and lamellar, and forms a thin sheet of fascia having important relations with the parts beneath. Dissecting this fascia upwards, it is found to be continuous in that direction, in front of the clavicle, with the superficial cervical fascia; below, it descends upon the abdomen; while downwards and outwards, along the base of the region, it is reflected over the lower edge of the pectoral muscle, to pass between it and the pectoralis minor, on the one hand, and on the other, to become lost in the loose cellular tissue of the arm-pit. Upon the shoulder, it continues with the superficial fascia of the arm, being attached in that situation, also, to the acromian process; and a little beneath the outer end of the clavicle, it penetrates between the deltoid and pectoralis major muscles, along the line which separates them, thus connecting itself with the deeper layer presently to be described. This superficial fascia adheres intimately to the surface of the muscle, especially along its axillary border, and although possessing no great thickness, it is sufficiently strong to impede the progress of matter to the surface, when that fluid is formed in the parts beneath.

The *muscles* occupying the anterior wall of the axillary region are, the pectoralis major and minor, the clavicular portion of the deltoid, and the subclavius. The first of these (*Fig.* 1. C. C.) occupies the whole surface, except a small part above, occupied by the deltoid. It is somewhat rhomboidal in shape,—is composed of fibres which converge as they advance outwards from their attachment to the ribs, sternum, and clavicle, towards the outer margin of the bicipital groove of the humerus; and consists of two portions, sufficiently distinct through their whole extent. The first is attached to the sternum and true ribs, and is called sternal portion: the second is attached to the inner half of the clavicle; it is denominated clavicular portion. They are united by cellular tissue, and when the arm is extended to a right angle with the body, a line drawn from the articulation of the inner end of the clavicle with the sternum, to the tip of the coracoid process, will indicate the situation of the union between the two portions of the muscle. This line will also correspond nearly to the course of the axillary artery, and an incision following it, will separate the clavicular from the sternal portion of the muscle, so as to fall upon the vessel without dividing any of the fibres. It is in this manner the incision is made in applying a ligature to the axillary artery, according to the method proposed by Marjolin, and recommended by Lisfranc.

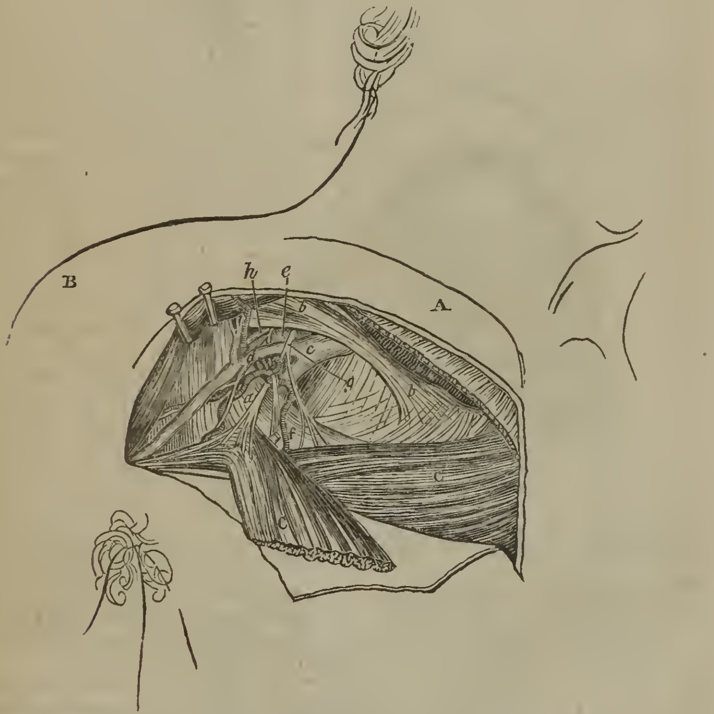
The inner part of the pectoralis major reposes, to a limited extent, upon the surface of the ribs. Immediately beneath the middle of the clavicle, it rests upon a bed of loose cellular tissue, the deep layer of fascia mentioned above,—the anterior thoracic arteries, veins, and nerves, and is here only separated by these structures from the axillary artery and vein, and the inferior chord of the brachial plexus of nerves. Farther outwards, it covers the pectoralis minor, a thin layer of fascia, and several small vessels and nerves running between the two muscles. Its outer, or inferior margin, which forms the anterior boundary of the arm-pit, is in relation with the mass of cellular tissue, lymphatic glands, blood-vessels, and nerves, which occupy that cavity. The upper portion of the muscle is separated from the deltoid by a well-defined furrow, which is occupied by the cephalic vein, as it passes upwards and inwards from the arm, to communicate with the axillary vein;—also by the principal branches of the thoracico-acromialis artery. The incision is made along this furrow in apply-

ing a ligature to the axillary artery according to the method recommended by Desault and Roux. The vein and acromial artery would be necessarily exposed to injury by such a procedure.

The attachment of the pectoralis major to the clavicle, indicates the necessity of confining the arm against the side of the body in fractures of that bone, in order to keep the fibres of the muscle relaxed; and the power it exercises upon the humerus, tends to displace the fragments when the shaft of that bone is broken. The relations of this muscle with the deep-seated cellular tissue of the axilla give it great importance in extensive collections of matter taking place beneath its surface. The pus is prevented by it from pointing at the surface, and is consequently driven profoundly among the deep-seated parts, producing burrowing abscesses, — or it travels through the loose cellular tissue, towards the arm-pit, and points in that situation. Were it not for the slight degree of resistance presented by the meshes of the cellular tissue in this direction, affording an easy transit to the matter, the pus would be much more apt to find its way through the intercostal muscles, and be discharged into the cavity of the thorax.

The *pectoralis minor* (*Fig.* 1. *a.* *Fig.* 2. *b.*), covered by the preceding, is of a triangular figure. Attached by its inner extremity to the third, fourth, and fifth,—

Fig. 1.



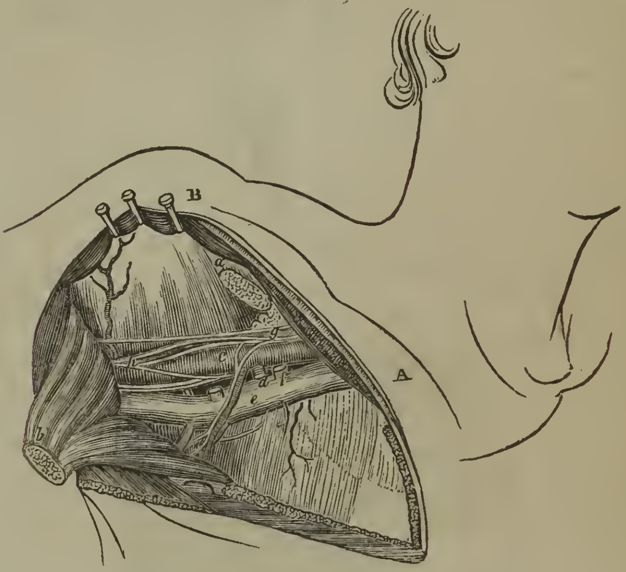
A, Clavicle. B, Deltoid. C, C, Pectoralis major. *a*, Pectoralis-minor. *b*, *b*, Costo-coracoid ligament. *c*, Axillary vein. *d*, Cephalic vein. *e*, Axillary artery. *f*, Superior thoracic artery. *g*, Anterior thoracic nerve. *h*, Part of the brachial plexus of nerves.

or the second, third, and fourth ribs, its fibres pass obliquely upwards and outwards, to the tip of the coracoid process, to which they are attached by a short tendon. (*Fig.* 2. *a.*) Besides the pectoralis major, and other superficial parts, it is covered in front by some loose cellular tissue, and a thin layer of fascia, which passes between it and the muscle just mentioned. It is likewise traversed, upon this aspect, by some small vessels and nerves (*Fig.* 1. *g.*), which descend from above, to be distributed to the pectoralis major and the serratus magnus. These vessels consist of some of the branches of the thoracica suprema, which takes its origin near the upper margin of the muscle. Near its outer attachment, the pec

toralis minor glides in front of the axillary artery, with its corresponding vein, and the axillary plexus of nerves—crossing them nearly at a right angle. It thus divides the axillary region into two triangular spaces, through which the principal vessels and nerves pursue their course.

The first of these spaces, denominated by Velpeau, costo-clavicular, is situated above the muscle, and is bounded, superiorly, by the clavicle and the subclavius muscle; internally, by the surface of the ribs, covered by the serratus magnus; inferiorly and externally, by the upper margin of the pectoralis minor. The axillary artery and vein traverse it obliquely, covered by a considerable quantity of cellular tissue,—by the deep-seated layer of fascia presently to be described, together with the aponeurotic expansion called costo-coracoid ligament (*Fig.* 1. *b.*); and over these parts, the pectoralis major. It is also in this space that the cephalic unites with the axillary vein (*Fig.* 1. *c, d.*); and towards its lower part, the superior thoracic artery generally takes its origin. (*Fig.* 1. *f.*) At this point, the axillary artery (*Fig.* 1. *e.*) can be most

Fig. 2.



A, Clavicle. B, Deltoid. *a*, Coracoid process. *b*, Pectoralis minor, detached from the coracoid process and reflected. *c*, Axillary artery. *d*, Thoracic artery. *e*, Axillary vein. *f*, Cephalic vein. *g*, Axillary plexus of nerves. *h*, Median nerve. *i*, Long thoracic artery.

easily reached, when it becomes necessary to secure it beneath the clavicle.

The lower triangular space, which may be called pectoro-humeral, is bounded above by the lower margin of the pectoralis minor; outwardly by the humerus; and inferiorly by the axillary border of the pectoralis major. It is occupied by the mass of loose cellular tissue already mentioned, by numerous lymphatic glands, and by the axillary vessels and nerves, which traverse its upper part, in the vicinity of the shoulder joint. The artery may be secured in this region; but as it is more intimately surrounded by the plexus of nerves, it cannot be so easily isolated as above. This space, however, is far more liable to the development of inflammation, abscesses, tumours, &c., and, consequently, to become the seat of surgical operations, than the space above the pectoralis minor.

The *subclavius muscle* occupies the lower surface of the clavicle throughout its whole extent, and the axillary artery and vein glide beneath it, covered by a tolerably strong aponeurosis, which surrounds the muscle, and passes off from it, the coracoid process, and clavicle, to be attached to the ribs. The small portion of the deltoid (*Fig.* 1. B.) which occupies the axillary region, presents nothing worthy of a particular notice, except so far as regards the furrow between it and the pectoralis major already alluded to.

The *deep-seated fascia* mentioned above,

must now be more particularly examined. When the pectoralis major is removed, a layer of fascia is seen spread out in front of the pectoralis minor, and the axillary artery and vein, where they pass through the costo-clavicular triangular space. It is continued outwards with the capsular ligament of the shoulder joint, and the deep portion of the fascia of the arm;—upwards, behind the clavicle, with the deep-seated cervical fascia; forwards with the superficial fascia covering the pectoralis major, in the manner indicated above; and backwards, upon the surface of the serratus magnus, and the posterior surface of the pectoralis minor. From the inner margin of the coracoid process, a strong lunated aponeurosis (*Fig.* 1. *b*, *b*.), having its concave edge downwards, ranges inwards, along the lower surface of the clavicle, to the whole extent of which it is attached, and becoming expanded at its inner extremity, is inserted by strong aponeurotic fibres into the cartilages of the first, second, and third ribs. This is the costo-coracoid ligament, or the ligamentum bicorne of Caldani. It furnishes a strong sheath for the subclavius muscle, and from its concave edge, a broad thin sheet of fascia is sent off, which is spread out upon the whole of the anterior surface of the pectoralis minor, and the space between that muscle and the surface of the ribs. Along the edge of the pectoralis minor, this fascia splits into two layers, one passing behind—the other in front of that muscle, so as to inclose it in a sheath, these lamina reuniting along its outer edge. A few lines below the middle of the clavicle, the fascia in question presents a crescentic opening, the inner border of which is concave outwards, while the superior is continuous with the corresponding lunated edge of the costo-coracoid ligament. The outer boundary of the opening is formed by the upper edge of the pectoralis minor. The office of this aperture is to transmit the cephalic vein, which, ascending along the outer face of the arm, along the furrow between the deltoid and pectoralis major, passes through it, to unite with the axillary vein, a little above the pectoralis minor. Above and behind it, is the axillary artery, which is crossed obliquely in front by the cephalic vein in this vicinity, and also by some small filaments of nerves which descend from the axillary plexus in front of the artery, to reach the pectoral and serratus muscles. The opening may be aptly compared to that in the fascia lata of the groin, which is traversed by the saphena vein; and as the relations of the axillary artery are here less complex than in other portions of the region, this point should be selected as the most eligible for the application of a ligature to that vessel. Behind the pectoralis minor we generally find the long thoracic artery (*Fig.* 2. *i.*) descending upon the surface of the serratus magnus, upon the fibres of which it is chiefly expended; and in its vicinity, another small branch, the thoracica alaris, which is distributed to the glands and other parts in the arm-pit.

The posterior wall of the axilla is far less important, both to the pathologist, and operative surgeon. Examining the structures composing it, from before backwards, in the order they present themselves, we find, first, a thin layer of cellular tissue, or fascia, lining the whole extent of this boundary. From a line corresponding to the base of the scapula, this fascia is reflected from the serratus magnus outwards, upon the surface of the subscapularis, teres major, and latissimus dorsi, sending prolongations between the lacerti of the first of these muscles, which attach themselves to the costal surface of the scapula; and others backwards, between the subscapularis and teres major. This forms a communication between the cellular tissue of the axilla, and that of the dorsum of the scapula. Upwards and outwards this fascia adheres intimately to the capsule of the shoulder joint, whence it continues downwards, on the long head of the biceps and the coraco-brachialis, to lose itself in the fascia of the arm. Upwards and inwards, it is lost in the cellular tissue which ascends behind the clavicle into the cervical region.

The *muscles* entering into the formation of the posterior boundary of the axilla, are those just mentioned. The subscapularis, occupying the whole extent of the concavity of the scapula, has its anterior face looking forwards and inwards, towards the ribs, from which it is separated by cellular tissue. Farther outwards are the teres major and latissimus dorsi, attached by a common flattened tendon, twisted upon itself, to the inner border of the bicipital groove of the humerus,—the latter muscle, which is posterior to the former, advancing in front of it where they become attached to the bone. The two together form the posterior fold, or wall, of the arm-pit; and between them and the outer margin of the subscapularis, there is a considerable space, occupied by cellular tissue, through which the circumflex branch of the subscapular artery is reflected backwards, to the dorsum of the scapula.

The inner wall of the axilla is formed by the walls of the thorax, and of course takes the convex figure of the ribs. It is occupied by the broad expanded fleshy portion of the serratus magnus, which, taking its origin from the eight or nine superior ribs, winds backward, to be attached to the whole extent of the base of the scapula. It is covered by a thin layer of fascia, which, as previously remarked, is reflected outwards from the line of the posterior attachment of the muscle, upon the surface of the subscapularis. It is obvious, from the manner the serratus magnus is inserted into the base of the scapula, that the internal and posterior walls of the axilla meet each other at a very acute angle, and that the disposition of these parts is such, that there is no natural outlet from the cavity in this situation. Matter, therefore, cannot travel backwards in this direction from the axilla, beyond the insertion of the serratus magnus into the base of the scapula,—that muscle presenting an insuperable barrier to its further progress. Nor is it likely that the inner wall will be traversed by pus accumulated within the axilla, since, in addition to the muscle already mentioned as occupying its whole extent, it is still further fortified by the ribs, intercostal muscles, and other structures pertaining to the walls of the thorax. Such an accident has nevertheless sometimes happened, and a case has been reported by Lawrence, in which an axillary aneurism found its way through this wall into the cavity of the chest. The angle formed by the union of the internal with the anterior boundary of the region is also acute; but here the arrangement of the parts is somewhat different. It sometimes happens, therefore, when extensive suppuration takes place in the axilla, that the pus is forced downwards, into the space between the serratus and pectoral muscles; or if that fluid should be formed in the latter situation in the first place, it may travel backwards and upwards, without encountering any formidable obstacle.

Descending upon the outer surface of the serratus magnus, near the lower margin of the pectoralis minor, we find the long thoracic artery, and not far removed from it, the external respiratory nerve of Bell, which, arising from the posterior part of the chord formed by the fifth and sixth cervical nerves, descends behind the brachial plexus, and appropriates its filaments to the serratus magnus. A wound of this nerve would produce paralysis of the muscle to which it is distributed, and the base of the scapula would, under such circumstances, be thrown backwards, or tilted upwards, from the ribs, so as to occasion great deformity about the dorsum of the shoulder. We have witnessed several cases of this deformity, arising from blows and falls upon the shoulder, the effect of which was, to overstrain or violently contuse the serratus muscle, and finally give rise to a temporary paralysis of its fibres. Velpeau also mentions a case, in which this condition supervened upon a contusion received in the arm-pit. (*Anat. Chirurgicale.* I. 303.) The deformity of the dorsum of the shoulder from this cause, is not generally understood, and we have known much embarrassment occasioned by it. It is, however, easily recognized. The individual has no power to draw the base of the scapula forward by the serratus magnus; but pressure upon the bone readily restores it to its proper place, which it deserts, however, as soon as the pressure is removed.

The upper and outer boundary is formed chiefly by the shoulder joint, and all that portion of the humerus above the attachment of the pectoralis major and latissimus dorsi. It is wider within than outwards, but does not present much interest in a pathological or surgical point of view, except the articulation and its structures, which will be considered when we come to describe the region of the shoulder.

The summit of the axillary region, directed upwards and inwards, is open to give passage to the axillary vessels and nerves,—they being surrounded by loose cellular tissue. The base is occupied by the skin, as already stated, which is folded upwards, so as to present a deep excavation between the folds formed by the pectoralis in front, and the latissimus dorsi behind.

The parts comprised within these boundaries must next be described. These are, the arteries, veins, nerves, lymphatics and cellular tissue.

The axillary artery (*Fig.* 1. *e. Fig.* 2. *c.*) and its branches have been already described (see *Arteries*); but it will be necessary to examine the relations of these vessels more particularly, in order to indicate the manner in which they can be most easily reached, or avoided, in surgical operations. This will also serve to point out some important indications in the treatment of wounds implicating the region under consideration.

Most anatomists of the present day de-

scribe the axillary artery as extending from the scalenus anticus muscle, to the outer border of the latissimus dorsi. This has led to great confusion in speaking of operations upon this vessel, in consequence of one portion of it being situated above the clavicle, or in the cervical region, while the other occupies the axillary region proper. To avoid this confusion, and in accordance with the limits which have been prescribed for this latter region, we shall restrict the term axillary to that portion of the artery which extends from the second rib to the outer edge of the fold of the arm-pit, formed by the latissimus dorsi muscle.

The axillary artery, thus defined, ranges downwards, outwards, and slightly backwards; and when the arm hangs by the side, describes a gentle curve, having its convexity upwards and outwards,—its concavity downwards and inwards. As the relations of the vessel, in its whole transit, are exceedingly complex, and important to be understood, it will be useful, in accordance with the plan pursued by Harrison and Velpeau, to divide it into an internal, a middle, and an external portion.

The first, or internal portion (*Fig.* 1. *e.*), extends from the second rib, to the upper margin of the pectoralis minor, and passes obliquely through the upper part of the claviculo-pectoral triangular space, previously indicated. In this course, it reposes at first upon the outer surface of the second rib and the corresponding intercostal muscle; but it gradually recedes from the side of the thorax, and is separated from the upper portion of the serratus magnus by cellular tissue. When, however, the arm is close by the side, it reposes to a small extent upon that muscle. The axillary vein is in front, but on a plane somewhat below the artery. When it is fully distended, however, the artery is nearly concealed by it. The cephalic vein, gliding in front of the pectoralis minor, to empty itself into the axillary, above that muscle, crosses the outer portion of this division of the artery obliquely in front. At its inner part, the artery has the subclavius muscle and the clavicle in front, and further outwards, the lunated aponeurotic expansion, extending from the ribs to the clavicle and coracoid process denominated costo-coracoid ligament (*Fig.* 1. *b.*); the thin layer of fascia which extends downwards from this expansion, and which is perforated above the pectoralis minor by the cephalic vein, as previously described;—and the pectoralis major muscle. Above, and behind, the artery is accompanied by the nervous chord of the brachial plexus, which is formed by the eighth cervical, and the first dorsal nerves. This nerve inclines more forward in its transit than the artery, and is consequently more intimately connected with it, at its outer, than at its inner portion; and just before it glides beneath the pectoralis minor, it sends a small thoracic filament downwards (*Fig.* 1. *g.*), between that muscle and the pectoralis major, which crosses the axillary artery in front, in an oblique direction.

The second portion of the axillary artery is concealed by the pectoralis minor, beneath which the vessel glides in its transit outwards. Like the preceding, it has the axillary vein in front, but more downward than in the region just described; and the several chords which form the axillary plexus, in separating from each other, twine upon the surface of the vessel and surround it by a kind of nervous sheath. Having, besides, the pectoralis minor in front, and furnishing in this situation, the principal thoracic branches, this portion of the axillary artery cannot be so readily secured in a ligature as the first division; and the greater facility of reaching the vessel in the latter situation, and of isolating it from the surrounding parts, indicate it as the most eligible point for the application of the ligature, when the operation cannot be performed upon the third portion of the vessel.

The third and last portion of the axillary artery (*Fig.* 2. *c.*) extends from the lower edge of the pectoralis minor to the outer margin of the latissimus dorsi, when it takes the name of brachial artery. In its course outwards, it reposes posteriorly upon the subscapularis muscle, which separates it from the capsular ligament of the shoulder joint, and courses along in front of the attachments of the teres major and latissimus dorsi muscles, having the same relations with the vein as in the region just described. The two radicles of the median nerve (*Fig.* 2. *h.*), where they approach each other, to unite in front of the vessel, have the latter placed between them—one root of the nerve being on its radial, the other on its ulnar aspect. The external cutaneous nerve is also on its radial side, as is likewise the coraco-brachialis muscle. The internal cutaneous follows its ulnar side, and the radial and circumflex nerves gradually recede from it, in proportion as they incline backwards. After the artery has passed the

subscapularis muscle, it courses along the coraco-brachialis, and upon the surface of the humerus, where, being superficial, it can be compressed against the bone.

A careful consideration of the relations of the axillary artery, in these three different portions of its course, will serve to show, that it cannot be easily tied, except in the first and third divisions. In the first, the principal obstacles are the great depth of the vessel, and its intimate connexion with the axillary and cephalic veins and the brachial plexus of nerves. But these difficulties can be surmounted, and as the artery seldom furnishes any branches until it arrives near the edge of the pectoralis minor, the chances of success are greater than if the ligature were to be applied in the immediate vicinity of the origin of a collateral branch. The second portion of the artery is also very deep-seated, and is, besides, covered by the pectoralis minor, so that to reach it, a division of that muscle, as proposed by Roux and Rust, would be necessary;—a procedure which ought never to be adopted. As it furnishes a portion of the thoracic branches, it is impossible to apply a ligature distant enough from the origin of those branches, even if the artery could be reached with ease, to admit of the formation of a coagulum of sufficient extent to obliterate its calibre. The third division of the axillary artery can be easily exposed, but it is so closely surrounded by the axillary plexus of nerves, that it cannot be isolated without considerable difficulty, and risk of injuring those parts. The same circumstance, together with the great liability of this portion of the artery to retract deeply in the midst of the cellular tissue of the axilla, occasions great embarrassment in securing the vessel at this point, after amputations at or near the shoulder joint.

The branches furnished by the axillary artery are of but slight importance in a surgical point of view. The *thoracico-acromialis*, which comes off near the upper edge of the pectoralis minor, mounts upwards and outwards, towards the shoulder, and when it runs in the intermuscular space between the pectoralis major and deltoid, is liable to be injured by wounds inflicted upon that part, and would be divided by the incision recommended by Desault and Roux for the purpose of reaching the axillary artery. The other thoracic branches generally arise near the same point as the preceding, or behind the pectoralis minor. They pass downwards to the two pectoral and the serratus magnus muscles, and are seldom implicated in surgical operations. Nevertheless, it sometimes happens, in diseases of the mamma, that some of these superficial branches become so much enlarged, as to bleed profusely when divided in the extirpation of such tumours. The subscapularis comes off on a level with the outer margin of the subscapularis muscle, and may have its descending branch wounded in extirpating tumours from the axillary cavity. As it follows the face of the muscle, this accident may in general be avoided; but if it should be wounded, the hemorrhage can always be restrained by ligature. In applying a ligature to the axillary artery, on the outer side of the pectoralis minor, care should be taken not to secure the vessel too near the origin of this branch, lest the free passage of a considerable collateral current through it, should wash away any coagulum that might be formed, and thus interrupt the process of obliteration.

The *veins* of the axillary region, which most deserve to be noted are, the axillary, and the basilic and cephalic which open into it. All the others are comparatively small, and although there is frequently a considerable plexus of venous branches in the axillary cavity, they are not of sufficient magnitude to render particular precaution requisite in the performance of operations on that region.

The *axillary vein* (*Fig.* 1. *c.*) is very large, and follows nearly the course of the artery of the same name, being in front, and a little below the plane occupied by that vessel. In the upper portion of the claviculo-pectoral triangle, where the vein passes beneath the clavicle, it is more in front of the artery than at any other point, and during expiration, when it is most distended, frequently conceals nearly the whole of that vessel. It is, besides, very closely adherent at this point, both to the artery, and the costo-clavicular aponeurosis,—an arrangement which renders it difficult to isolate the former, without inflicting injury upon the vein. Farther outwards, it inclines somewhat more downwards than the artery, and leaves that vessel more exposed; but in the whole of its transit, its great size, and its close relations with the axillary artery, not only render it difficult to pass an aneurism needle beneath the latter vessel, but expose the vein itself to laceration or division with the knife. Such an accident, besides giving rise to profuse venous hemorrhage, may prove fatal by

admitting air into the veins, and should consequently be carefully avoided.

The *basilic vein* does not always terminate in the axillary at the same point; but in a majority of instances this communication takes place before the latter vessel reaches the pectoralis minor. This, however, is a matter of but little moment, as the two veins run parallel, and are but slightly removed from each other. But in extirpating tumours from the axilla, as well as in cutting down upon the artery in that region, both these veins are much exposed to injury, and great circumspection is requisite in the dissection, to avoid implicating them. Such tumours are, indeed, oftentimes so closely adherent to these veins, that they have rather to be separated by the handle, than the edge of the knife.

The *cephalic vein* (*Fig.* 1. *d.*) is more superficial, and is also greatly exposed to injury. Ascending along the outer portion of the arm, in a direction slightly spiral, when it reaches the anterior part of the shoulder, it runs superficially in the intermuscular depression between the anterior edge of the deltoid, and the pectoralis major. It finally glides in front of the coracoid process; becomes more and more profound as it advances inwards from that point, and having reached the upper edge of the tendon of the pectoralis minor, crosses the axillary artery obliquely in front, from above downwards and inwards, and communicates with the axillary vein. (*Fig.* 2. *e.*) It is at this point that the cephalic vein traverses the opening formed by the costo-clavicular ligament and the deep layer of fascia previously described; and as the corresponding portion of the axillary artery is generally selected for the application of the ligature, it is sometimes difficult to pass the thread without injuring the vein. This vein, also, like the thoracico-acromial artery, would be divided in the operation for securing the axillary artery proposed by Desault.

The *nerves* of the axillary region (*Fig.* 2. *g.*), after what has been said, do not require a particular description. They consist of the axillary plexus and its branches. In the inner portion of the region, these nerves are above and behind the artery,—only one of the chords—that formed by the union of the eighth cervical and the first dorsal, being sufficiently near it to be concerned in any operation performed upon the vessel. A little above the margin of the pectoralis minor, however, one or two small thoracic filaments (*Fig.* 1. *g.*) are sent downwards by this nerve, which descend obliquely outwards, in front of the artery and vein, to supply the muscles of the anterior part of the thorax. These may be incautiously divided in attempting to reach the artery, but such an accident would probably occasion no serious consequences. Behind the pectoralis minor, the nervous chords recede from each other, a part of them getting below the plane of the artery, while the others remain above and behind. Still further outwards, the vessel is firmly bound down by the two roots of the median nerve (*Fig.* 2. *h.*), which meet upon its surface, and, with the other branches, surround it with a kind of nervous sheath. This renders it the more difficult to isolate this portion of the axillary artery, to secure it by ligature; and when these parts are divided in amputation, the vessel often retreats so much, between the nervous chords which surround it, that it cannot be easily found and secured. The proximity of these nerves to the shoulder joint, exposes them greatly to contusions, pressure, and other injuries resulting from dislocations happening at that articulation. It is for this reason, that such accidents are so often attended with severe pain, numbness of the arm and hand, or even complete paralysis. Pressure upon the veins, from the same cause, frequently occasions great tumefaction of the whole member; and these vessels, as well as the artery, may be lacerated, either by the dislocation, or violent attempts to reduce it, as will be explained in a subsequent part of the present article.

The *lymphatics* of the axillary region are both numerous and important. Those of the arm, the side of the thorax, and a portion of those of the neck, converge towards this point, and form a very intricate plexus about the blood-vessels. They likewise present clusters of lymphatic ganglia, disposed in series, and deeply imbedded in the cellular tissue. The largest cluster of these ganglia reposes upon the serratus magnus; but there are others, placed more immediately in relation with the axillary artery and vein, both behind and in front. These lymphatic ganglia and vessels are very liable to take on disease; and it is not unusual, whenever the points whence they take their origin are affected with inflammation, suppuration, and degenerations of various kinds, to find these vessels transmitting the morbid process along their entire length, to the glands in the axilla—becoming themselves acutely inflamed,

thickened, indurated,—filled with pus or other morbid products, or otherwise transformed from their normal condition. This is more particularly the case in poisoned wounds of the fingers and hand, as those which are received in the dissection of dead bodies. Under such circumstances, the lymphatics along the whole extent of the arm present red, inflamed streaks, excessively painful to the touch; the glands of the axilla become inflamed and enlarged; the cellular tissue takes on a species of diffuse inflammation; and the whole axillary region is finally involved in suppuration, or sloughing. In many pathological conditions of the mammæ, also, the glands of the axilla are remarkably prone to take on disease, and in cancer of that organ, it is well known, that the chief obstacle to success from an operation is, the implication of the axillary ganglia in the morbid affection.

The cellular tissue is very abundant, and loose in its meshes. Having numerous lymphatic vessels and glands embedded in its substance, and being traversed by the blood-vessels and nerves, it not only fills up the greater part of the proper axillary cavity, but is prolonged thence into the int rstices of the muscles. From the axilla, a considerable portion of it passes upwards behind the clavicle, to communicate with the cervical region. Collections of matter, therefore, forming in the neck, often infiltrate downwards, and point in the axilla, and *vice versâ*. This tissue is also prolonged, as previously stated, beneath the pectoral muscles, and it often happens, that purulent deposites become diffused extensively in this direction, forming at the same time an extensive accumulation in the axillary excavation.

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Art. II. Surgical Pathology. The numerous and important structures which occupy the axillary region, render its surgical pathology a subject of great interest to the practitioner. Under this head may be included, phlegmonous and erysipelatous inflammation of the skin and cellular tissue; inflammation of the arteries, veins, and lymphatics; abscess; ulceration; tumours of various kinds; wounds of the axilla in general, and those implicating the axillary artery and vein, and the axillary plexus of nerves; aneurism, and ligature of the axillary artery; and aneurismal varix implicating this vessel and the axillary vein.

1. *Inflammation of the Axilla.* The various tissues composing the axilla are liable to inflammation, which may take on either the phlegmonous or erysipelatous character. Under each of these forms, it often presents several modifications, according to the condition of the individual, the tissues affected, and the extent to which the inflammation is diffused.

A furunculoid form of inflammation very often attacks the skin of the axillary fossa. It probably has its origin in the sebaceous follicles, and is excited by friction, by a neglect of cleanliness, and other causes tending to create irritation in the part. It generally presents itself in form of one or more circumscribed elevated phlegmons, hard to the touch, and surrounded by an inflamed areola. The proper remedies are quietude and cleanliness;—leeches, fomentations, poultices, &c., and when matter forms, a small puncture to give it a free exit. In some instances, when the constitution is unhealthy, the inflammation assumes the character of carbuncle,—is extremely painful, and is attended with great general disturbance. The treatment appropriate for carbuncle in other parts of the body should be instituted, and the tumour should be opened early, to allow of the escape of the slough from its centre. This may be done either by the knife or caustic.

Erysipelatous inflammation very often attacks the skin and cellular tissue of the axilla. When it extends deeply, it is a truly formidable disease, sometimes giving rise to extensive sloughing of the whole of the deep-seated cellular tissue, laying the vessels bare, and burrowing between the muscles. The skin presents an erythematous blush; the region of the pectoral muscle is puffed up, and is doughy to the feel; the axillary space is full and

prominent; and the inflammation is not unfrequently diffused upon the neck, chest, and extremity. This form of inflammation may take place spontaneously in the part; but it is frequently induced by injuries of the hand, fingers, or fore-arm; the lymphatics becoming inflamed in their course along the member, transmitting the disease from the seat of injury to the axillary region, upon which it seizes with a great degree of intensity. This is particularly the case after pricks or other wounds received in dissection, the inflammation excited by which, has a remarkable tendency to take on the diffused character, attended with extensive sloughing, and to involve the whole member in common with the axilla, or to pass by the former, and seize upon the latter alone.

At the onset of the disease, leeches may be applied freely over the inflamed part, followed by soothing anodyne lotions, either tepid or cold—fomentations, and the ordinary means of combating erysipelatous inflammation. When the disease extends profoundly into the cellular tissue, free incisions are by far the most important means, and should not be dispensed with. They disgorge the blood-vessels, remove constriction, and if sloughing has commenced, give free exit to the unhealthy matter and sloughs of the cellular tissue, situated beneath the skin. (See *Erysipelas.*)

2. *Abscess of the Axilla.* The characters of the structures composing the axilla, dispose them in a high degree to abscess and its consequences. Independently of those abscesses which form in the axilla from simple idiopathic inflammation of the cellular tissue and lymphatic glands, there are others, which arise from causes of a different nature. Hence it is found, that critical and pestilential abscesses form more frequently in the axilla than in any other part of the body; and the looseness of the cellular tissue in this situation; its intimate relations with parts possessing a great susceptibility to disease, together with the freedom of its communication with other regions, dispose it, in a peculiar manner, to accumulations of matter, having its origin in an affection of some organ either adjacent or remote. The neck, the shoulder joint, the dorsum of the scapula, the arm, and even the cavity of the thorax, may be the source of purulent deposites in the axilla, the fluid traversing freely the meshes of the cellular tissue in the direction in which it encounters the least obstacle, until it points in the arm-pit. Besides these, there are

abscesses by congestion, the sources of which cannot be recognized. They generally take place in broken-down habits, in which the blood-vessels, or the tissues themselves, seem to acquire the property of forming purulent deposites in the axilla, independently of any manifest inflammation or appreciable local lesion, either in the part or the neighbourhood. More frequently, however, the abscess is either a consequence of inflammation of the cellular tissue or glands of the axilla, or the matter finds its way into this region, from a disease of some of the neighbouring parts. Pockels mentions a case, in which it proceeded from caries of the coracoid process; and a second, in which the matter originated in a disease of the seventh cervical and the first dorsal vertebra, where the latter articulates with the head of the first rib. (*Encyclopädisches Wörterbuch.* I. 270.) The accumulation of pus was not preceded by any evidence of inflammation in the axilla. Velpeau reports two cases in which an abscess formed upon the shoulder, and the matter traversed the joint, to point in the arm-pit. (*Dict. de Méd.* II. 97.) In both cases, the abscess was a consequence of amputation;—in the first, of the arm;—in the second, of the little finger. In another instance, caries of the third rib was the cause of the disease; and the same author reports two other cases, in one of which the abscess communicated by an oblique aperture, six lines in diameter, with cavities in the lungs; while in the other, the matter proceeded from behind the sternum. But whatever be the character assumed by abscesses of the axilla, it is probable, that in a majority of cases, the cause of the disease is inflammation of the lymphatic vessels and glands, extending to the surrounding cellular tissue, and exciting extensive suppuration in its meshes.

However this may be, these abscesses are often more formidable than is generally supposed. The reason of this can be readily understood, when the nature and relations of the parts are considered. The great permeability of the cellular tissue, together with its high degree of extensibility, is very favourable to the formation of large purulent collections. Its continuity with that of adjacent regions allows the fluid to travel with great facility,—upwards, behind the clavicle, into the cervical region; forwards, beneath the pectoral muscles; backwards, upon the dorsum of the scapula; downwards, upon the arm; and in some cases, the inter-

costal muscles are destroyed, and the pus is either extravasated into the cavity of the thorax, or a fatal degree of pleuritic inflammation is developed. Owing to these conditions, it frequently happens, that while an abscess exists in the axilla, others are formed in the lower part of the neck, upon the dorsum of the scapula, in some portion of the shoulder, arm, &c., which, on a careful examination, are found to be mere appendages of the one in the arm-pit, with which they communicate freely. VELPEAU has reported several such instances; and many more might be collected from the annals of the science, in which the great irritation thus excited was productive of fatal consequences. The long confinement of the matter, may, besides, give rise to caries of the bones; and when the parietes of the thorax become perforated, or involved to the extent of exposing the pleura, the case is generally hopeless,—death being almost always inevitable. HILDANUS mentions the case of a child, in which an abscess of the axilla separated the pleura from the ribs, and attacked the lung. (*Observ. Chirurg.* Obs. 2. VELPEAU.) A similar condition was found by SANSON, in a young woman who died at Hôtel-Dieu, except that the pleura was merely exposed by the destruction of the intercostal muscles. (*Lond. Med. and Surg. Journ.* V. 668.) Even when the abscess does not find its way into the thorax, the inflammation may be transmitted to the pleura, and destroy life by exciting extensive serous or purulent effusion from the surface of that membrane. Two cases of this kind are mentioned by VELPEAU; and he reports another, in which death was induced by a large abscess of the axilla, opening into the upper part of the thorax. (*Loc. Cit.* 99.)

The *treatment* of abscesses of the axilla may bo dismissed in a few words. It consists in opening them early, and freely, in order to evacuate the pus, and prevent the supervention of those formidable consequences so apt to take place from the burrowing of the matter when it is suffered to accumulate in the deep-seated parts. This course we would recommend, whether they be simple, pestilential, carbuncular, lymphatic, or congestive. An opposite practice, it is true, has been inculcated by respectable authority, but upon very questionable grounds. Thus, it has been enjoined not to open pestilential or critical abscesses; but to leave the matter to be absorbed or evacuated spontaneously. The same course has been advised, in those abscesses which arise from suppuration taking place in the lymphatic glands. Our own experience is unfavourable to such a procedure, and we would enjoin it as a rule, seldom to be departed from, that in these, as well as in other cases, the matter should be freely evacuated, as soon as fluctuation can be perceived. It will save the patient much suffering, hasten the cure, and above all, prevent the pus from diffusing itself amongst the neighbouring parts. Sometimes, indeed, it will be necessary to make a deep puncture, to evacuate the fluid, even when fluctuation cannot be discovered, especially if the other symptoms be such as to leave no doubt in regard to the existence of a deep-seated abscess. In performing the operation, a sharp-pointed bistoury should be preferred, and the puncture made, if possible, in the most dependent part. But as the method of procedure, as well as the after-treatment, have been already indicated in the article *Abscess*, they need not be repeated.

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3. *Tumours of the Axilla.* Tumours possessing various characters form in the axillary region. Some of these have their origin in the structures occupying the part itself, independently of any remote affection; others are purely sympathetic, —the diseased condition being a consequence of a previous morbid condition of some other part of the body. SEIFERT has, therefore, very properly divided tumours of the axilla into two classes;—the idiopathic and symptomatic. The propriety of this division is more especially indicated in such tumours as arise from a diseased state of the axillary glands; and as it rarely happens that tumours are developed primarily in the other structures of the arm-pit, we shall consider the subject in accordance with this arrangement.

a. *Tumours which do not originate in the glands.* It should be premised, that the axilla occasionally becomes the seat of idiopathic tumours, which do not originate in the lymphatic glands. These are of two kinds;—the first merely consisting of an infiltration of blood, or air, in the cellular tissue of the arm-pit and adjacent structures;—the second, of a morbid growth either of the soft parts, or of the bones in the vicinity.

Examples of the first species are often

observed after attempts to reduce dislocations of the shoulder joint, and at first view, are apt to occasion much alarm, on account of the similarity presented by such a condition, to traumatic aneurism from laceration of the axillary artery. The tumefaction under such circumstances, is owing to the injury sustained by the small veins and arterial ramifications of the cellular tissue of the axilla, which being torn across, pour out blood, and produce an extensive ecchymosis. The tumefaction generally disappears promptly under the influence of rest and cold spirituous lotions, the extravasated blood being absorbed.

Violence inflicted upon the part, either in the manner indicated, or by other means, not unfrequently gives rise to extensive emphysema, by which the whole of the arm, and the adjacent part of the thorax, neck, and shoulder, are puffed up into a soft elastic tumour. Velpeau mentions a case, in which this accident was induced by a fracture of the clavicle, notwithstanding the lung was not wounded. In another case which fell under his observation, the axilla became the seat of an emphysematous tumour, merely in consequence of the efforts of coughing. (*Dict. de Méd.* II. 103.) When emphysema results from an injury sustained by the lung, the axilla almost always participates. Under all these circumstances, the disease must be treated on general principles. (See *Emphysema.*)

A case will be mentioned in a subsequent part of this article, in which the subclavian artery was tied, as was supposed, for axillary aneurism; but after the death of the patient, it was found that the condition which had been supposed to be aneurism, was a firm tumour adhering to one side of the artery, and implicating the brachial plexus. Mayo has recorded a case, in which an exostosis of the first rib obliterated the axillary artery, and occasioned violent pulsations above the clavicle, simulating aneurism (*Lond. Med. and Phys. Journ.* 1831.); and an individual was admitted at St. Thomas's Hospital, with an axillary tumour, which by part of the surgeons of that institution was supposed to be aneurism. As there was a difference of opinion amongst the consultants, it was determined to puncture it: the operation gave issue to a considerable quantity of serous fluid, bringing with it a number of small hydatids. (*The Lancet.* VIII. 211.) Diseases of the shoulder joint, of the scapula, the outer end of the clavicle, the ribs, &c., may also give rise to tumours extending into the axilla; but such affections do not require a particular description.

It has been remarked above, that tumours affecting the glands of the axilla may be divided into idiopathic and symptomatic. Each of these orders of tumours may be subdivided into species, according to their characters. Thus, under the head of idiopathic tumours, we have the inflammatory; the scrofulous; the cancerous, including the scirrhous, encephaloid, and melanotic. Symptomatic tumours may arise either from a previous local affection of some other part;—as inflammation of the fingers, or paronychia; dissection-wounds, or other injuries of the hand, arm, &c.; and morbid affections of the mammæ;—or from some constitutional condition,—as syphilis, scarlatina, typhus fever, plague, &c.

b. *Idiopathic glandular tumours of the Axilla.* The simple inflammatory enlargement of the axillary lymphatic glands does not require a particular or detailed description. The parts affected are hard and tense to the touch; one or more of the glands become enlarged and indurated; the superjacent skin is occasionally red and inflamed; and the motions of the arm are painful, and performed with difficulty. Sometimes the tumour is small and movable; but occasionally, when an entire cluster of glands is involved, it acquires a large size; is hard and lobulated to the feel; and is so firmly united with the surrounding parts, as to maintain it fixed or but slightly movable. Such a condition may be excited by any of the ordinary causes of inflammation, either general or local; and the disease may terminate in resolution; the inflammation may become chronic, leaving a permanent enlargement and induration of the glands; or it may end in abscess. The treatment must be conducted according to the general principles already laid down in speaking of inflammation and abscess of the axilla.

Scrofulous tumours of the axillary glands are of more frequent occurrence, and are far more important, as regards their consequences. They are dependent upon a general scrofulous diathesis, are developed slowly, without apparent preceding inflammation, and are generally unattended with pain, except when they become so large as to encroach upon the surrounding parts, or are themselves attacked by inflammation and suppuration. In nearly all cases, they are preceded by glandular tumours of the same kind in

some other part of the body, especially in the neck, and are besides accompanied with the ordinary indications of a general scrofulous diathesis. At first, there is generally a slight enlargement of one or more of the axillary glands, which are isolated and movable. But in the progress of the disease, a whole cluster becomes involved, and the several enlarged glands are conglomerated into a solid lobulated mass, partially or entirely filling the axilla, compressing the vessels and nerves, and producing tumefaction, numbness, and pain of the whole limb, with inability to perform with it any of the ordinary movements. Sometimes these tumours are as large as the head of a child, or even an adult, and force the arm from the side to such a degree that it cannot be brought down. Such tumours are generally so closely adherent to the surrounding parts, that they are firmly fixed, and are for the most part immovable. In some instances, nevertheless, even when they have attained a large size, they can be moved with considerable freedom.

The pathological characters of these axillary lymphatic tumours are extremely variable, and very often different portions of the diseased mass are found in very dissimilar conditions. Sometimes there is simply a state of hypertrophy of the tissue of the glands and the surrounding cellular tissue: very often tuberculous matter is disseminated through the tumour in considerable quantity; and this is found in all the intermediate conditions, between the state of simple crudity in which it is deposited, and that of disorganization. In this latter state, it is incorporated with purulent matter, and the tumour itself presents excavations of variable size, filled partly with the fragments of caseous matter, resulting from the breaking down of the tuberculous masses, and pus poured out by the surrounding textures. These cavities are sometimes small and isolated; but as the disease progresses, they frequently run together, and the whole axillary region becomes filled with one immense scrofulous abscess, possessing hard and insensible walls, and pouring out unhealthy secretions. When such abscesses penetrate deeply amongst the vessels and nerves, they are apt to become fistulous, and cannot be easily healed. Under such circumstances, constitutional irritation and hectic gradually undermine the powers of life, and the individual is finally destroyed by exhaustion.

The *treatment* of scrofulous tumours of the axilla is the same as that which is appropriate in other diseases of an analogous character. The remedies for scrofula, both local and general, must be employed, and varied to suit the circumstances of the case. Sulphuret of antimony, in small doses; mild mercurials, administered with a view to the alterative effects of the remedy; muriate of baryta; acorn coffee; the preparations of iodine; animal charcoal, recommended by Gumpert (Rust's *Magazin der gesammten Heilkunde.* XXV. 121.); cicuta, and other agents employed in the treatment of scrofula, may be resorted to here. The dietetic precepts, recommended in that disease, will also be applicable to this, and should be carefully observed. The local treatment must consist for the most part of lotions, ointments, baths, plasters, to be preceded, when inflammation exists, by a few leeches. The salt poultice has been much recommended for the dispersion of such tumours; as have also the ointments of mercury, either simple, or combined with camphor, cicuta, and other substances possessing stimulating or narcotic properties. By far the most valuable agents that can be employed under such circumstances are, the preparations of iodine, employed in form of ointment. For the manner of using them, and an account of the different preparations, see *Iodine*, and *Scrofula.* When suppuration takes place, and the tumour becomes fistulous, it has been recommended to transfix the entire mass with a seton. This course may be expedient in some cases; but it will generally be preferable to lay open the sinuses freely, and dress the cavity of the abscess from the bottom, putting the patient at the same time upon a generous diet, and giving him the advantage of pure country air. In this condition, bandages, so adjusted as to maintain equable and gentle pressure, will also be useful, and should not be neglected. Should these means fail, and the tumour become so large as to interfere seriously with the motions of the arm, it may be removed by an operation. This expedient should not be resorted to when the glands of the neck, and other parts of the body, are extensively involved, inasmuch as such a condition shows, that the system is too far implicated, to admit of much benefit being realized from the removal of the axillary tumour. Under more favourable circumstances, the diseased mass may sometimes be dissected out with success, and this should not be neglected, when all other remedies have failed. Several cases have been reported by Velpeau, in which

he practised this operation with complete success. (*Dict. de Méd.* II. 106., and *Journal Hebdomadaire.* No. 51. p. 276. 1835.) The same practice also proved highly satisfactory in the hands of GOYRAND. (*Lancette Française.* II. 257. 1829.)

The steps of the operation must of course vary according to the size and situation of the tumour. When it can be reached from the arm-pit, the incision should be made at that point; but when it is larger, and extends upwards beneath the pectoral muscle, it should be dissected out beneath the clavicle, by extending the incisions through the skin and pectoralis major,—dividing also the pectoralis minor, should it be necessary to do so.

Scirrhous, encephaloid, and *cancerous tumours,* seldom form in the axilla, except when they are sympathetic of a similar degeneration of the mammæ, or of some part of the arm, or shoulder. To this rule, however, there are some exceptions. VELPEAU mentions a case, in which fungus hæmatodes originated in this situation. He states that two others had been mentioned to him by OLLIVIER, and that there is one of the same kind recorded in the Theses of Paris. (*Op. Cit.* p. 103.) The resources of art generally avail but little against tumours of this class; the event being almost invariably fatal, even though the disease be extirpated with the greatest care. If the disease be observed at an early period, and be sufficiently isolated from the surrounding parts, the operation may be justifiable, even though there be but little hope of success.

c. *Symptomatic glandular tumours of the Axilla.* The causes of these tumours, already indicated, convey a sufficiently accurate idea of their nature. As the conditions which give rise to them vary, it must be apparent that their characters must also be exceedingly dissimilar. Those which depend upon a venereal taint, possess all the properties of other glandular swellings produced by that virus, and are, like them, liable to suppurate and terminate in troublesome sores. Paronychia, dissection-wounds, and other diseases and accidents affecting the hand and arm, likewise give rise to swellings of the axillary glands, which are prone to suppurate. Sometimes, indeed, these accidents, especially dissection-wounds, are followed by inflammation and swelling of the axillary glands, attended with extensive sloughing of the surrounding parts. (See *Wounds.*) Critical swellings of the axilla from scarlatina, typhus, small-pox, &c., and the pestilential tumours, which form in plague, need not be described in the present article, as they can be more appropriately considered in connexion with the diseases to which they belong. It will be sufficient to remark, that they generally terminate in abscess, and very often by extensive gangrene, and sloughing. Enlargement of these glands from diseases of the mammæ are of frequent occurrence. The enlargement may be either a result of simple inflammation, transmitted to the glands from the mammæ, or it may be of a scirrhous or cancerous character, the morbid process being extended to the axilla by the lymphatic vessels which communicate with the mammary gland. (See *Mammæ, Diseases of.*)

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4. *Wounds of the Axilla.* Wounds of the axilla, not implicating the large vessels and nerves, although not usually very formidable, nevertheless present several points of interest to the surgeon. The peculiar laxity of the skin and cellular tissue of the axillary fossa, together with the mobility and the peculiar configuration and relations of the parts, render it difficult to maintain the edges of such wounds in a state of coaptation. In whatever position the member be placed, the lips of the wound are apt to be either drawn asunder, or folded upon each other in such a manner, as to interfere with union by the first intention. Besides, the small vessels which are wounded, generally bleed sufficiently to inject the loose cellular tissue with blood to a considerable extent; and in some cases, this takes place to such a degree, as to prove a source of great irritation, or even to give rise to extensive suppuration—a condition which is very apt to take place in this situation under all circumstances. We do not think, however, that such wounds will often give rise to the species of traumatic emphysema, mentioned by VELPEAU (*Dict. de Méd.* 2d ed. II. 103.), by the mere infiltration of air between the edges of the wound.

a. *Wounds of the axillary artery.*

Wounds of this artery may be either incised, punctured, or lacerated. The two former varieties, inflicted by sharp instruments, generally bleed profusely; but the latter is very often unattended with hemorrhage, although the vessel be entirely severed, or the arm be torn from the body at the same time.

Incised and punctured wounds may reach the axillary artery through the space between the pectoralis major and the latissimus dorsi, or they may penetrate the pectoralis major at some point below the clavicle, corresponding to the course of the artery, and thus divide its tunics. The immediate phenomena attendant upon such an accident, will of course vary according to the extent of the external opening, and the depth and direction of the wound through the parts surrounding the vessel. When the aperture is small, the direction of the wound very oblique, or its depth great, there is often very little blood discharged externally after the first gush; but that fluid, driven into the meshes of the cellular tissue, and diffused into the spaces between the muscles, accumulates there, until the whole axillary region becomes enormously distended by a mass of coagulum, and the bleeding is either arrested by syncope, or the coagulum obstructs the orifice of the wounded artery, and thus commands the hemorrhage. Under such circumstances, the pectoralis major is protruded forwards, so as to be rendered prominent beneath the clavicle; the axillary hollow is effaced by the distension of the skin and cellular tissue; the scapula is tilted upwards from the side of the chest; and the shoulder, with the outer end of the clavicle, is often considerably elevated. Should the external opening be large enough to allow the blood to flow away, or the wound of the artery such, as to preclude the possibility of the hemorrhage being arrested either by syncope or coagulum, death soon ensues from the loss of the vital fluid, unless it be arrested by the assistance of art. Even when an arrest of hemorrhage does take place by either of the processes indicated, it is generally only of temporary duration — the bleeding being renewed from time to time, until stilled by death; or after being commanded for several days, it breaks out afresh, after the development of suppuration in the wound, and the consequent displacement or dissolution of the coagula which served to command it for the time. Sometimes, nevertheless, when the wound of the vessel is favourable to the development of those changes by which hemorrhage is spontaneously arrested, the bleeding is not renewed in this manner, but the coats of the artery, together with the adjacent tissues, undergo such modifications, that while they serve to restrain the hemorrhage, they give rise to a false consecutive aneurism.

In the article *Arteries*, it was stated, that wounds only implicating a small extent of a vessel, are capable of being closed by the spontaneous efforts of nature, so as to leave its calibre entire. Although such a result cannot often be expected in wounds of so large an artery as the axillary, there are some cases recorded, which render it probable that such a termination may sometimes be realized. Certain it is, the artery may be severed in this situation, and yet the wound heal without the assistance of art, or the development of a false consecutive aneurism. Van Swieten reports the case of a peasant, who had the axillary artery wounded by a knife. The hemorrhage was so alarming that the individual was left for dead. The police officers, on proceeding the next day to examine the wound, finding some warmth about the region of the thorax, were induced to defer the investigation. By proper attention, the powers of life were gradually restored, and the man recovered without further inconvenience. (Van Swieten. *Comment. in Boerh. Aph.* I. 235. Bérard. *Dict. de Méd.* IV. 486.) A more satisfactory case is reported by Guthrie. (*On the diseases and injuries of arteries.* p. 308.) A master tailor of the British army, was wounded in the right arm by a pike, at the assault on Badajos. He bled like a pig, according to his own account, and became faint; but as his wound was thought to be trifling on his arrival at the spot indicated for surgical assistance, no attention was paid to him, notwithstanding he fainted. He experienced but slight inconvenience on the next day; but it was afterwards found, that the arm was cold and powerless; that the wound, about one third of an inch in length, and a little below the edge of the pectoral muscle, was directly over the seat of the artery; that the arm was numb and pulseless at the wrist, although the pulse could be distinctly felt upon the artery as low as the seat of injury, which was harder and a little more swollen than natural. The temperature of the arm gradually returned, and after the expiration of something more than a fortnight, the pulse could be felt a little below the wound, and after-

wards along the edge of the biceps muscle; but a good deal of unpleasant numbness remained in the fingers and thumb.

Far more frequently it happens, when the hemorrhage ceases spontaneously, that after the expiration of a short time, a pulsating tumour is observed in the situation of the wound — a false consecutive aneurism being the consequence of the inadequate restoration of the injured parts. Such an aneurism may be either diffused or circumscribed; but if small at first, it generally expands with great rapidity, and soon becomes so large as to fill the whole axillary cavity; or if it be seated above the pectoralis minor, it becomes diffused extensively under that muscle and the pectoralis major. A very interesting example of this kind is reported by Larrey, in which amputation became necessary. An officer was wounded in single combat, with the point of a sword, which penetrated the axilla near the head of the humerus, and not only punctured the artery, but partially divided the adjacent portion of the biceps muscle. The withdrawal of the instrument was followed by profuse hemorrhage, which, however, was easily arrested by the compress and bandage; and under the use of a uniting bandage the wound healed by the first intention. Subsequently, however, a pulsating tumour made its appearance at the situation of the cicatrix, which rapidly increased in size, until it filled the whole axilla—being as large as the two hands. In consultation, it was decided that amputation should be resorted to, and the limb was successfully removed at the shoulder joint. (Larrey. *Clinique Chirurgicale.* III. 132. Paris, 1830.) Another case, in which amputation was rendered necessary by a false consecutive aneurism of this artery, is reported by Debaig. (Bérard. *Dict. de Médecine.* IV. 486.) To these may be added the cases observed by Desault, Sabatier, Chamberlain, Hodgson, and Langenbeck, which we shall have occasion to notice under the head of aneurism of the axillary artery. In all these instances, false consecutive aneurism supervened upon a wound inflicted upon this vessel, and rendered the ligature of the artery necessary.

It sometimes happens that the wound implicates both the artery and the vein. Under such circumstances, if the hemorrhage should cease spontaneously, or be arrested by pressure, the artery projects a portion of its blood into the vein through the orifice of communication, thus occasioning a preternatural dilatation of that vessel, presenting all the characters of a varicose aneurism (q. v.).

It will sometimes be difficult to form a correct diagnosis in wounds of the axilla. A wound of the artery may be easily distinguished from one implicating the vein, by the colour of the blood, and the manner in which it escapes from the wound. If the artery be wounded, the blood will be vermilion, and thrown out in jets; whereas if the vein alone be implicated, dark venous blood will flow away, in nearly an even stream. The greatest difficulty will be experienced, when the hemorrhage is arterial, in distinguishing whether the axillary artery itself be wounded, or some important branch furnished either by that vessel, or some other. A profuse hemorrhage may take place from one of the thoracic arteries—the subscapular, circumflex, or even one of the intercostals, and awaken a suspicion that the main artery itself has been wounded. In most cases, however, a wound of the axillary artery will be attended with a complete suspension of the pulse at the wrist, and great coldness and numbness of the member. But although these phenomena may be regarded as affording strong presumption of the nature of the injury, they cannot be deemed conclusive; since the cessation of the pulse may take place in injuries implicating one of the branches, either from syncope resulting from the loss of blood, or in consequence of such an accumulation of extravasated blood about the main artery, as to intercept the circulation through it by pressure. The coldness and numbness, it will readily be conceived, may be induced in the same manner. If, however, these characters be taken in connexion with the situation and direction of the wound, and all the other collateral circumstances, most of the difficulties may be surmounted.

Lacerated wounds of the axillary artery are far more frequent than such as are inflicted by cutting instruments. Their most common cause is gun-shot or other projectiles; but they are sometimes occasioned by individuals falling from a height, and lighting with the axilla upon some obtuse projecting body. The axillary artery has also been several times torn across by the force employed to reduce dislocations of the shoulder of long standing; but the most formidable injuries of this vessel are those which happen when

the entire member is torn from the body by machinery, some examples of which have been recorded.

The same phenomena which have been described, when treating of wounded arteries in a preceding article, are observed when the axillary artery is injured. In this, as in other vessels, the effect of the wound will sometimes vary considerably, according as the artery is partially or completely severed. It is well known, that lacerated wounds, even of large arteries, are not much disposed to bleed profusely; and several cases have been reported, in which no hemorrhage ensued, notwithstanding that the axillary artery was torn entirely across. When, however, a musket-ball implicates a portion only of the diameter of the vessel, the bleeding is apt to be profuse, and to continue, unless arrested by art, until life is destroyed. At the battle of Talavera, GUTHRIE was induced to examine a French soldier, who had just expired from loss of blood occasioned by a musket-ball, which passed through the pectoral muscle in the direction of the axillary artery, making its exit behind. On dividing the muscle, he found the artery cut more than half across—the portion which remained unsevered, preventing the contraction and retraction of the extremities of the vessels, which were necessary to arrest the hemorrhage. (*Op. Cit.* p. 305.) In some cases, however, the vessel, though struck by the ball, is not torn; its elasticity protecting it against the laceration which would otherwise be inflicted. The consequence of such an injury may be either inflammation and consequent obliteration of the vessel, or the development of consecutive hemorrhage by sloughing of its tunics. The author just quoted has given examples of both of these terminations, in wounds of the axillary artery. Captain GIBBONS was wounded by a musket-ball, which passed immediately below the clavicle, and out behind, so directly in the situation of the axillary artery, that it was supposed it must be injured. Great inflammation followed in the chest, and his life was saved with difficulty. He finally died of phthisis, and it was found that the artery was obliterated at the point where the ball had passed by its side. (GUTHRIE. *On wounds and injuries of the arteries.* p. 303.) No alarming degree of hemorrhage is mentioned as having occurred at the time, indicative of a destruction of the coats of the artery; but in the case of a French prisoner, who was wounded at the battle of Salamanca, it was found necessary to apply a ligature to an axillary artery several days after the receipt of the injury, in consequence of sloughing of the coats of the vessel. (*Op. Cit.* 304.)

Although but few cases have been reported, of laceration of the axillary artery by attempts made to reduce dislocations of the head of the humerus, there is reason to suspect that many such accidents have occurred in practice. It happened in two instances in the hands of Professor GIBSON of Philadelphia, both of which were fatal. (*Philada. Journ. of the Med. and Phys. Sciences.* VII. 81. 1823; and *American Journ. of Med. Sciences.* II. 136. 1828.) It is stated by CHARLES BELL, that in employing the ambe, in the New-Castle infirmary, both the axillary artery and the muscles were torn, rendering immediate amputation necessary (*Operative Surgery.* Amer. edit. II. 176.); and Professor GIBSON refers to another instance of laceration of this artery, by attempts to reduce a dislocation of the shoulder, on the authority of PELLETAN. (*Clinique Chirurgicale.* II. 95.) A case of the same kind is also reported by FLAUBERT, which occurred in the Hôtel-Dieu of Rouen. The artery was found torn entirely across, a little above the origin of the subscapular branch. (*Repertoire Général d'Anat. et de Physiologie*, &c. III. 55. Paris, 1827.)

In some of these instances, nothing was observed at the time, to awaken a suspicion of the accident that had happened. In FLAUBERT's case, however, the counter-extending bandage was scarcely removed, before an enormous tumefaction appeared beneath the pectoral muscle; the countenance became pale; the lips livid, and the eyes death-like: the pulse was also extinct at the wrist. The swelling was, however, attributed to an emphysematous condition of the cellular tissue of the axilla; and as the nature of the injury was not ascertained until the next day, when the circumstances were such as to forbid the application of a ligature to the subclavian artery, the mischief continued until the limb became gangrenous. In the cases reported by Professor GIBSON, the phenomena were developed less promptly; but as they had made sufficient progress in the last, by the second day, to indicate the character of the injury sustained, a ligature was applied to the subclavian artery on the third day. Notwithstanding this precaution, the case went on to a fatal termination.

As the efforts at reduction are often productive of great tumefaction of the

parts, and not unfrequently, of an emphysematous, or bloody, distension of the cellular tissue of the axilla and beneath the pectoral muscle, it will be difficult to distinguish those cases in which the artery is torn. Desault reports a case well calculated to point out the difficulty of diagnosis under such circumstances. It was a dislocation of a month and a half standing, which, after some difficulty, was reduced; but immediately afterwards, a tumour rose suddenly under the pectoralis major; propagated itself towards the armpit, and occupied immediately its whole extent. All the assistants, astonished at the phenomenon, knew not to what circumstance to attribute it. Desault himself, a little embarrassed, thought first of an aneurism suddenly produced by the violence of the extension. The pulse of the patient, being scarcely perceptible in the side affected, and syncope which supervened, appeared at first to favour this suspicion; but immediately, the absence of fluctuation, of pulsation, and of a change in the colour of the skin,—the return of the pulse, the circumscription of the tumour, its resistance, and the sound caused by striking on it, produced a belief, that it was owing, not to an effusion of blood, but to a disengagement of air that had been confined in the cells of the now lacerated cellular membrane. Under the use of proper applications to the parts, the tumour was entirely reduced. (Desault. *On Fractures and Dislocations.* Translated by Charles Caldwell. p. 149. Philadelphia, 1817.)

Laceration of the axillary artery, from the cause mentioned, is generally associated with so much injury of the surrounding parts, that little hope of recovery from such an accident can be entertained. Not only is the vessel torn, but likewise the muscles, cellular tissue, and sometimes also the nerves. The blood is, besides, driven deeply into the cellular tissue, and if the individual should not be immediately destroyed, violent inflammation will be apt to ensue, involving the whole member in gangrene. The principal circumstances creating a liability to such an accident are, a diseased state of the artery, and the contraction of preternatural adhesions between it and the dislocated head of the bone. Similar connexions are sometimes formed between the head of the humerus and the chords of the brachial plexus of nerves; and attempts at reduction, under such circumstances, may tear up the roots of these nerves from their connexions with the spinal marrow, as happened in some cases reported by Flaubert in the memoir already quoted.

The appalling cases, in which the axillary artery is severed by the entire arm being torn from the body, are fortunately of rare occurrence. The first instance of this kind of which we have any knowledge, is one reported by Cheselden. (*Philosoph. Transact.* and Cheselden's *Anatomy.* p. 321. Plate xxxviii. London, 1756.) The subject of the case was a miller, who got his arm caught in a rope, the other end of which was fastened to the cogs of a mill. The vessels bled very little, and the arteries and nerves were drawn out of the arm. The surgeon who was first called placed them within the wound, which was dressed superficially, and the next day the patient was placed under the care of Mr. Ferne, of St. Thomas's Hospital, where he finally recovered without suffering any severe symptoms. Two other cases of the same kind are reported, both of which happened in children. The first is recorded by La Motte, in his *Traité des accouchemens;* the second by Carmichael, in the *Edinb. Medical Commentaries*, Vol. V. In La Motte's case, the bleeding was so slight that it was stopped with a little lint; and the same absence of hemorrhage was observed in the other case: both terminated favourably;—the first in a short time,—the second in two months. (Art. *Wounds*, in Cooper's *Surg. Dict.*) The following case, reported by Sir Charles Bell (*The Principles of Surgery*, &c. By John Bell, with Commentaries, by Charles Bell. I. 369. London, 1826.), is so important as to merit a more detailed report. A girl had her arm torn off near the shoulder, by machinery. There was no bleeding, nor could the trunk of the artery be seen. As the arm had been almost fairly amputated by the machine, it was unnecessary to do more than make the edges of the wound even, and bring them together. As the axillary artery had not been tied, the patient was carefully watched. In the course of a few days hemorrhage came on, and Mr. Smith, of the Leeds Hospital, very properly tied the artery just below the clavicle. The bleeding from the stump immediately stopped, and everything went on well for several days; the stump became clean, and was granulating, when a second violent hemorrhage took place from it. Mr. Smith, on reaching the hospital after the patient had lost a considerable quantity of blood, immediately tore open the stump,

which was already partly united, and saw the blood issuing from the main artery. The vessel was secured, but the patient sunk next day, and on dissection, it was found that the artery was obliterated where it had been tied, and that the blood had passed round by the supra-scapular branch of the inferior thyroid, from the portion of the subclavian artery above the ligature, into the part below.

The first care of the surgeon, on being called to a case of wound of the axillary artery, should be to command the flow of blood, by compression of the subclavian where it passes over the first rib. The manner of doing this has been described already, when treating of wounds of the arteries. (II. 438.) Having confided this duty to a competent assistant, he should, without delay, if the condition of the patient will admit, proceed to search for the end of the bleeding vessel, and secure it in a ligature. The ease or difficulty with which this operation can be accomplished, will depend upon the portion of the artery that has been wounded, and the degree to which the surrounding parts have become injected with blood. When the outer third of the vessel is injured, it can be generally drawn out and tied without great trouble or embarrassment; the external wound, if small, being previously dilated to the proper extent, so as to expose the jet of blood thrown out by the end of the artery. Sometimes, however, the parts are so filled with coagulated blood, as to occasion considerable difficulty, and the artery is so closely surrounded by the corresponding nervous chords, as to render its separation rather troublesome. If, however, the wound of the integuments be sufficiently large, and the coagulated blood be carefully turned out from the parts in which it is lodged, the operation may be accomplished with considerable facility. Great care will be necessary, however, in passing the ligature, not to include the nerves, and to avoid injuring the axillary vein. In some cases, a ligature to the upper end of the vessel will be adequate to command the hemorrhage; but as there is a great liability to hemorrhage from the other end of the artery, in consequence of the passage of the blood round through the collateral vessels, it will generally be much safer to apply two ligatures;—one above, and the other below the wound. The chances of such an accident will be greater when the artery is wounded above the origin of the subscapular branch, which, from its considerable size, and its very free anastomosis with the supra scapular, furnishes a very free channel by which the blood may be transmitted from the subclavian artery to the portion of the axillary below the wound. It will be advisable, therefore, in most cases in which the vessel is wounded high up, to apply a ligature to both ends. The propriety of this practice is strongly indicated by the case quoted above from Charles Bell, in which, notwithstanding the axillary artery was obliterated where the ligature was applied, the hemorrhage was renewed through the communication of the collateral branches with the lower end of that vessel.

When the artery is wounded higher up, where it is concealed by the pectoral muscles, much more difficulty will be encountered in applying a ligature. Still, the same precepts should be observed. Free incisions should be made through those muscles, upon the course of the artery; the coagulated blood turned out, and the vessel carefully isolated from the accompanying veins and nerves. The surgeon should not hesitate to divide a few muscular fibres, and if the case demand it, it will be far better to cut the pectoralis minor boldly across, than to be groping fruitlessly in a deep and narrow wound in search of the artery, which is so concealed in the bed of coagula as to render its discovery extremely difficult. By pursuing this course, the end of the wounded artery in all cases where the injury is recent, may be secured by ligature; and this should never be neglected when the hemorrhage is profuse, or when the blood is thrown into the surrounding parts in such quantity as to threaten a great degree of distension, and the subsequent development of inflammation and gangrene. When neither of these conditions exist;—when there is little or no external hemorrhage, and but slight distension of the parts in the vicinity of the wound by the accumulation of blood within the cellular tissue and beneath the pectoral muscle, it has been suggested, that instead of resorting immediately to the operation, the case should be managed by other means, until either a consecutive false aneurism is developed, or the vessel is spontaneously obliterated. The cases already quoted from Van Swieten and Guthrie, prove, that under favourable circumstances, the hemorrhage may cease without the assistance of art, and the wounded artery become impervious at the seat of injury. We have it in our power, in some instances, to promote this favour-

able issue, by a properly adjusted compress and other means, and if the case be of a kind to promise any prospect of success from such a procedure, it certainly should be preferred to a formidable operation, which, unfortunately, too often fails of success. Occasionally, indeed, a favourable termination may be obtained without the ligature, even after a false consecutive aneurism has formed. SABATIER (*Médecine Opératoire*, Nouvelle ed. par SANSON et BEGIN. III. 124.) reports an interesting case of this kind, in an officer who had an aneurism of the axillary artery, in consequence of a wound inflicted by a sword. It was treated by VALSALVA's method, together with the application of powdered oak bark, wet with red wine, to the tumour; and was under this management completely cured. Another instance of an analogous kind is recorded by HODGSON, on the authority of GOOCH. A child, aged nine years, fell with an earthen dish under his arm, a fragment of which wounded the axillary artery. He was in an instant deluged with blood, and fainted. The wound was dressed, and healed in a few days; but on removing the dressings, it was found that there was some hardness at the site of the injury, attended with pulsation. The tumour and pulsation gradually increased, and at the end of a few weeks, the former became so large as to project beyond the axilla. It then ceased to extend—gradually subsided, and eight months afterwards the pulsation was scarcely perceptible, and the pulse at the wrist very feeble. In eighteen months, every vestige of the tumour had disappeared, and the patient had completely regained the strength of his arm. (HODGSON. *Traité des maladies des Artères*, &c. Traduit par BRESCHET. II. 352.)

There are but few cases, however, in which so fortunate an issue can be anticipated. If the artery be not secured at the time the injury is inflicted, and the blood should cease to flow externally, it will either be driven extensively into the cellular tissue, occasioning enormous tumefaction of the whole axillary region, shoulder, and upper part of the arm, or a false consecutive aneurism will be developed, which will increase rapidly, and render the operation indispensable. The first of these conditions, if not remedied by an operation, is very apt to be followed by violent inflammation, and gangrene of the whole extremity. This can only be obviated by cutting down freely upon the course of the artery, removing the coagula as far as possible, and securing the severed ends of the vessel. We think that such a condition can but rarely demand amputation; yet it is possible, that in extreme cases, such an expedient may become necessary, as in the examples already referred to on the authority of LARREY and DEBAIG. When an aneurism has formed, it will be better to resort to the ordinary operation for that disease,—the application of the ligature some distance above the injury, than to endeavour to find the end of the artery, when it has been divided. This course will be rendered preferable, by the changes developed in the coats of the artery, and in the surrounding structures, at the seat of the wound, making it difficult to isolate the vessel on the one hand, while the latter, from its fragility, will be apt to break under the ligature. In all other cases, however, the ligature should be applied to the ends of the vessel in the wound.

It may also become necessary to apply a ligature to the axillary artery, in consequence of that vessel being opened by sloughing of the surrounding parts, involving its tunics. GUTHRIE remarks, that after the battle of Salamanca, he was obliged to apply a ligature on the axillary artery, which had not bled for several days, until the artery sloughed. (*Op. Cit.* p. 304.) DELPECH (*Chirurgie Clinique.* I. 7. BÉRARD.) tied this vessel, in consequence of sloughing of the brachial artery: the artery was cut by the ligature, and the hemorrhage recurred: a ligature was then applied to the vessel below the clavicle, and although the circulation was re-established through the collateral vessels, the individual was attacked with hospital gangrene, and died. In another instance in which the axillary artery was opened by hospital gangrene, GALTIER, an assistant of DELPECH, applied a ligature to the subclavian artery; but notwithstanding there was no renewal of the hemorrhage, the case terminated fatally. (*Loc. Cit.* p. 18; and BÉRARD, *Dict. de Méd.* 2d edit. IV. 490.) MONTEATH was more fortunate in a case in which he tied the axillary artery, on account of sloughing of its tunics. (*The Lancet.* I. 730; and BÉRARD, *ut supra.*) Under such circumstances, the ligature should always be applied upon a healthy portion of the artery, some distance above the situation of the opening, as in the Hunterian operation for aneurism.

A review of all the cases in which a ligature has been applied to the axillary artery, on account of a wound of that

vessel, shows conclusively, that the result of the operation is far less favourable under such circumstances, than when it is performed for aneurism. The explanation of this difference is obvious, when the state of the parts in the two conditions is duly considered. When the artery is tied on account of a wound, there is not only the injury inflicted by the operation, but likewise that which renders its performance necessary. The surrounding parts are sometimes extensively involved—perhaps violently lacerated, and generally filled with extravasated blood. The veins and nerves may be also injured, rendering the parts more liable to take on a high degree of inflammation and sloughing. These are, indeed, consequences almost inevitable, after the infliction of so much violence upon the parts; but there are other circumstances which have considerable participation in producing the disparity of success in the two cases alluded to. In aneurism, the long-continued impediment to the passage of the blood through the main artery, produces a gradual dilatation of the collateral vessels, so that when the ligature is applied, the circulation is carried on with sufficient freedom through the anastomosing vessels, to maintain the nutritive action of the parts beyond the point of obstruction. When, on the contrary, a ligature is applied on account of a wound of the axillary artery, this preparatory dilatation of the collateral vessels not having preceded, the supply of blood is cut off, and the limb is apt to fall into a state of gangrene. The truth of this explanation is corroborated by the result of several cases, in which the artery has been tied under the circumstances mentioned. This happened in a case in which DESAULT tied this vessel, by making an incision through the pectoral muscle. (DESAULT'S *Surgical Works*. Translated by ED. DARREL SMITH. I. 478. Philada. 1814.) DEBAIG cites two cases, in which gangrene of the arm followed the operation (BÉRARD. *Dict. de Méd.* IV. 490.); and in the case of a child, in which the artery was tied by MAUNOIR, three fingers were destroyed by mortification, notwithstanding the operation was crowned with success. (BÉRARD. *Loc. Cit.*)

5. *Wounds of the veins of the Axilla.* The veins of the axilla may be wounded, either by violence accidentally inflicted upon the parts, or in the performance of surgical operations; and such injuries are sometimes associated with a wound of the axillary artery, the brachial plexus of nerves, and other important structures contained within the axillary region. The ill consequences liable to result from such an accident are, venous hemorrhage; the introduction of air into the veins, and sudden death; phlebitis; and, finally, when the artery is wounded simultaneously, the development of an aneurismal varix, by the propulsion of the stream of blood from the latter vessel into the vein.

Venous hemorrhage from the axilla can be readily distinguished from arterial, by the dark colour of the blood, and by its flowing away in a steady current, rather than being thrown out in jets. It can be generally commanded by pressure, even when the axillary vein is wounded, and if the surgeon be called in time, is not usually near so formidable an accident, as when the corresponding artery is injured. (See *Hemorrhage*, and *Wounds of the Veins.*)

The accidents resulting from the introduction of air into the veins have been already considered by Professor WARREN. (See article *Air.*) A case is there reported, in which death was suddenly induced by the division of a vein in the axilla, which was immediately followed with a gurgling sound, resulting from the introduction of air into the veins. Other cases of a similar kind have been observed by BEAUCHENE, CASTARA, CLEMOT, and DELPECH. In the first, the accident happened during the extirpation of a tumour from the shoulder, involving a portion of the outer extremity of the clavicle. The vein was wounded in attempting to remove the diseased bone. CASTARA'S case was a tumour occupying the dorsum of the scapula, and the vessel wounded was a branch communicating with the subscapular vein. In the instance reported by DELPECH, the operation which led to the accident was amputation of the shoulder joint, performed on account of great hypertrophy of the vessels of the arm. Death ensued in every instance, except the one reported by CLEMOT, in a few minutes. (OLLIVIER. *Dict. de Méd.* 2d ed. II. 68.)

Phlebitis attacking the axillary vein, may be regarded as almost necessarily fatal, on account of the proximity of the heart. All necessary information in regard to this subject will be found under the article treating of the pathology of the veins, and need not be detailed here. We shall speak of aneurismal varix of the axillary vein in a subsequent part of the present article.

6. *Wounds of the nerves of the Axilla.* The same causes that are instrumental in

inflicting a wound upon either the axillary artery or vein, or both at the same time, may implicate the corresponding nerves. The latter, however, may be wounded, and the vessels escape; although when the injury is inflicted by a sharp instrument, or gun-shot, it will seldom happen that one will be implicated without the other. These nerves are also exposed to violent contusions, and some of them are probably sometimes lacerated, in dislocations of the shoulder joint, in fractures of the neck of the humerus, and in violent attempts to replace the dislocated bone. When a dislocation of the head of the humerus downwards has been allowed to remain for several weeks or months, the bone contracts very intimate adhesions with the axillary vessels and nerves, so that any attempt made to return the bone, by breaking up its adventitious adhesions by force, may not only lacerate the artery, as already indicated, but likewise inflict a corresponding injury on the nerves.

In whatever way the axillary nerves be wounded, the consequence is, paralysis of the member, when all the nerves are wounded, or of particular muscles, when only one or more of the nervous chords are implicated. The paralysis involves both sensation and motion;—the arm is numb and powerless; its temperature is often diminished; and in many instances, the muscles become greatly atrophied. The loss of power, however, is sometimes only temporary; for although a nerve be completely severed by a cutting instrument, it has been satisfactorily ascertained, that reunion between the divided ends, will, in process of time, restore the function. This will be more apt to take place in simple incised wounds, than in those which are contused and lacerated, and attended with loss of substance. (See *Nerves, pathology of;* and Descot, *sur les affections locales des nerfs*, &c. Paris, 1825.)

Very little can be done in the way of treatment in such cases. At the time the injury is inflicted, the wound must be managed on general principles, and if, as sometimes happens, when a nerve has been but partially divided, or otherwise injured, there should be great pain, it must be allayed by opium. Artificial warmth may sometimes be necessary to maintain the temperature of the member; and with the view of promoting the re-establishment of the nervous influence over the muscles, after sufficient time has elapsed for reunion to be completed, frictions and galvanism should be resorted to.

These nerves sometimes sustain an injury of a much more formidable character, from violent efforts made to reduce ancient dislocations of the shoulder joint. The axillary plexus having connected itself by adhesions with the head of the humerus, when the extending and counterextending force is applied to the head of the bone, the nerves being unable to yield at the point of adhesion, are dragged with the member, and their roots are torn asunder from the spinal chord. This very serious accident was first particularly noticed by Flaubert, of Rouen, who has recorded a fatal case in which it occurred—besides others, in which the violence was followed by paralysis and wasting of the limb. (*Repertoire d'Anat. et de Physiologie pathologique.* III. 55. Paris, 1827.) In one of these cases, the luxation had existed five weeks, and was reduced by Flaubert, in the Hôtel-Dieu of Rouen, by means of extension made by eight pupils of the house. At first, the individual cried out violently on account of pain; but soon her ability to do so seemed to be overcome, by the compression of the chest, and a sense of suffocation. Immediately after the reduction, an emphysematous condition diffused itself from above the clavicle to the middle of the back;—the countenance became pale; the pulse feeble; and nausea supervened. At the same time, a sense of coldness and numbness was experienced in the left thigh and leg, which were so sensitive, that the patient cried out with pain on the slightest touch. This was on the 8th of December, and on the 22d death took place.

Besides extensive injury of the muscles and other parts, the following evidences of violence were presented by the nerves: they were agglutinated on a level with the arm-pit, by dense cellular tissue, presenting the appearance of having been for some time the seat of a moderate degree of inflammation. This tissue formed a kind of sheath for the nerves, above and below, but gradually diminished in quantity in both directions. Near the scaleni muscles, the ruptured extremities of the nerves were discovered. The four last pairs composing the brachial plexus were entirely severed; the first pair had escaped unhurt. Those which were severed had their roots torn from their connexion with the spinal chord, and the filaments by which they take their origin, could be

distinctly recognized. The ganglions attached to the posterior roots could likewise be distinguished, and were drawn out from the intervertebral foramen; but presented no other appreciable alteration.

Flaubert reports examples of other luxations, in which the efforts made to effect the reduction, were followed by permanent paralysis; and the conclusion at which he arrives is, that many cases of paralysis of the arm, usually attributed to the luxation itself, are owing to the injury inflicted by the attempts made to replace the bone.

Bibliography.—Flaubert. *Mémoire sur plusieurs cas de luxation, dans lequels les efforts pour la réduction ont été suivis d'accidens graves*; in Breschet's *Repertoire d'Anatomie et de Physiologie Pathologique.* III. 55. Paris, 1827.

7. *Aneurism of the axillary artery.* The axillary artery is liable to all the forms of aneurism that take place in other portions of the arterial system. Several cases of traumatic aneurism of this vessel have been already quoted; but it is, besides, very subject to that form of the disease which takes place spontaneously. The liability of the axillary artery to this disease, though greater than that of many vessels of both larger and smaller size, is nevertheless far less than that of some others.

The popliteal and femoral arteries exhibit a remarkable proneness to aneurism; —so much so, that of one hundred and seventy-one cases of this disease collected by Lisfranc, fifty-nine were popliteal; fifty-four femoral; and fourteen axillary. (Lisfranc. *Des diverses méthodes et des différens procédées pour l'oblitération des Artères*, &c. Paris, 1834.) When, indeed, we reflect upon the intimate relations of this vessel with the shoulder joint; its great liability to suffer injury in the various, and often violent, movements of the upper extremity; the accidents to which it is liable in the displacements of the articulations; and the diseases and injuries to which the axillary region is exposed; it is matter of surprise, that the artery in question is not oftener attacked with aneurism, both traumatic and spontaneous. The liability of attempts to reduce ancient dislocations of the shoulder joint, to lacerate the coats of the axillary artery, has been mentioned in the preceding remarks. Pelletan mentions two instances, in which aneurism of this vessel was induced by the individuals being in the practice of suspending themselves by the arms, on account of a rheumatic affection. In the same manner, the disease is occasionally developed, where the coats of the vessel are diseased, by the exertion of lifting heavy burthens,—and by blows, contusions, and other injuries inflicted upon the axilla.

Aneurisms of the axilla, when once developed, increase with great rapidity, and soon attain a very large size. This is a natural consequence of the slight resistance afforded by the adjacent parts, and the looseness of the cellular tissue which surrounds the vessel. The pectoral muscles are forced forwards, and under the distension of the tumour, their fibres become attenuated: the scapula is protruded backwards and outwards from the thorax, —the shoulder and clavicle upwards; and the natural concavity of the axillary fossa is effaced; the skin being forced outwards by the distension of the tumour. When the latter has attained a large size, the deformity resulting from the derangement of the natural relations of these parts is very great. The shoulder is tilted upwards, so as to be elevated sensibly above the level of the one on the opposite side: the scapula is forced backwards from the ribs to a considerable distance; and the whole shoulder and limb, rendered numb and tumid, by the pressure upon the veins, lymphatics, and nerves, are deprived of the faculty of motion, and become completely useless; or if movable, every attempt to exercise the arm is productive of great pain and difficulty. Sometimes, indeed, the long-continued pressure of the tumour upon the nerves, produces a notable degree of atrophy of their substance; and the operation of the same cause upon the veins and lymphatics, obstructing the free return of the blood and lymph from the extremity, occasions a high degree of œdema of the whole member, — which is thereby rendered stiff, painful, and sometimes livid and cold. The pulse at the wrist is also considerably modified; it is generally very weak, and in many cases cannot be felt.

The direction in which the tumour expands, is somewhat influenced by the portion of the artery from which it takes its origin. When it springs from the outer portion of the vessel, meeting with but little resistance from the skin spread over the axillary fold, it of course protrudes in that direction with great facility—at the same time that it forces the pectoralis major forwards, and the latissimus dorsi and teres major, together with the scapula, backwards. But even then, it cannot attain a large size without producing considerable elevation of the shoulder, because

of the resistance afforded by the skin where it is reflected off from the surface of the ribs. If, however, it proceeds from the portion of the artery comprised within the claviculo-pectoral portion of the region, it cannot so readily expand outwards. It is resisted in front by the pectoralis major and the costo-coracoid ligament; above by the clavicle; inwards by the ribs; and outwards by the pectoralis minor muscle, where it passes in front of the vessel. Here then, it is more apt to be obscure or concealed in the early part of its development; to proceed less rapidly; but at the same time to inflict more injury on the surrounding parts. The vein and nerves are forcibly compressed, —the former sometimes obliterated: the pectoral muscles are attenuated; the clavicle is forced upwards, so as to encroach greatly upon the neck, and is sometimes nearly destroyed by the encroachments of the tumour; the scapula is carried backwards, putting the serratus magnus upon the stretch, and this muscle is occasionally completely atrophied by the constant pressure of the aneurism. The subscapularis muscle is frequently wasted from the same cause, and in extreme cases, the scapula itself, as well as the ribs, are extensively eroded. Lawrence has reported a very interesting case, calculated to show the extent of the ravages that may be produced by an axillary aneurism. The tumour occupied the whole axilla, and extended upwards to the neck. The clavicle and upper ribs were denuded and eroded, and about three pints of coagulated blood were evacuated from the tumour, besides some masses of fibrinous concretions. A process of the tumour was prolonged upwards, in the inferior portion of the neck, above the sternum; and a second, of larger size, extended into the thorax, between the first and second ribs, the convex surface of which adhered to the lung. (*Lancet*, and Bérard, *Loc. Cit.* p. 492.) Two cases are also reported by Colles, in one of which the scapula was rough and denuded, while in the other, the aneurismal sac communicated with the cavity of the shoulder joint; the adjacent portion of the capsule being destroyed. (*Edinb. Med. and Surg. Journ.* 1815; apud Bérard, *Loc. Cit.*) In a case reported by Pelletan, the pressure of the tumour upon the axillary vein, obliterated that vessel, which was found closely adherent to the sac. If the disease be suffered to proceed unchecked, it finally terminates by rupture, as is the case with aneurisms of other parts of the body, and the patient is destroyed by hemorrhage.

In some cases, axillary aneurism terminates more favourably, even though the assistance of art be entirely withheld; the artery above the tumour, or the sac itself, being entirely obliterated by the spontaneous and unassisted powers of nature. We have already, in speaking of wounds of the axillary artery, cited cases in which false consecutive aneurisms of that vessel were cured without an operation, or dissipated by the method of Valsalva. Several others, of an analogous character, have been recorded. In some of them, the cure was effected by an obliteration of the axillary artery itself, while in others, the same termination was induced by the subclavian artery becoming closed above the tumour; the blood, under both conditions, being diverted into the collateral vessels. An individual entered St. Bartholomew's Hospital, labouring under an aneurism of the axillary artery; but as he had previously suffered from a disease of the same kind on the other side, which disappeared spontaneously, he refused to submit to an operation. The aneurism finally ruptured, and he was destroyed by hemorrhage, when it was found, that the aneurism which had formerly occupied the axilla of the opposite side, had been cured by spontaneous obliteration. (Hodgson. *Op. Cit.* II. 94.) The instances in which aneurism of the axillary artery is cured spontaneously by obliteration of the subclavian are numerous, and will be referred to under another head. (See *Cervical region.*) But it sometimes happens, that even when obliteration of the artery takes place, the aneurism continues to expand, and to undergo the usual changes, until its walls finally give way, and the patient is destroyed by the loss of blood. In a case of aneurism examined by Pelletan, he found the axillary artery obliterated, and the tumour so large as to reach the clavicle. Immediately below the aneurism, the artery was converted into a ligamentous substance, and would not admit even the smallest-sized probe. (*Clinique Chirurgicale.* II. 93.) Monro also witnessed a case, in which an aneurism occupying the axilla, descended as low as the arm. It finally ruptured, and destroyed the patient by hemorrhage, and on examining the parts, the artery was found communicating with the aneurismal sac, but at the same time it continued along its posterior surface, where it was almost impermeable to the extent of half an

inch. Below the point, indeed, at which the vessel communicated with the tumour, it was nearly obliterated by an adherence of its tunics. (*Edinb. Med. Essays.* III. 196; and Hodgson.)

The *diagnosis* of aneurism in this region, is sometimes attended with so much difficulty, that serious mistakes have occasionally been made; — aneurismal tumours having been opened for abscesses, and the axillary or subclavian artery tied, on account of tumours, which were afterwards found to possess nothing of an aneurismal character. In one of the cases reported by Pelletan, a large aneurismal tumour of the axilla was mistaken for an abscess, and with the view of drawing off its contents gradually, a small puncture was made, when, instead of pus, a jet of arterial blood issued from the wound. The pressure which was resorted to, in order to arrest the flow of blood, produced sloughing, and a fatal hemorrhage ensued. (Bérard. *Loc. Cit.*) It is also stated that Ferrand, in one case, made a similar mistake, and plunged a bistoury into an axillary aneurism, presuming it to be an abscess. (Richerand. *Nosograph. Chirurg.* IV. 75.) When the tumour is seated beneath the pectoral muscles, not being very conspicuous externally, it is not unusual for it to be mistaken for some other affection, or if it be attended with pain and difficulty of moving the limb, to treat it for rheumatism. In one case, Baker, of the New Castle Infirmary, applied a ligature to the axillary artery on account of a tumour of that region which was supposed to be aneurism, but which it was afterwards ascertained was fungus hematodes. (*The Lancet.* II. 210.) In 1830, the subclavian artery was tied by Earle, at St. Bartholomew's Hospital, on account of a tumour of the axilla which was supposed to be aneurism. The individual recovered from the effects of the operation, but died in 1835. On examination, it was discovered that the tumour, which was situated below the clavicle, along the course of the brachial plexus of nerves, was oblong, two inches in length, and about an inch and a half in width. Its surface was white, and within, it consisted of a grayish dense substance, divided into separate portions by white lines extending through it in various directions: the axillary artery was firmly united to one side of the tumour by dense cellular tissue, and the subclavian artery, at the seat of the ligature, was closed. (*Lond. Med. Gazette.* VI. 241. 1830, and XVI. 514. 1835; and *Am. J. Med. Sc.* XVIII. 516.)

The *treatment* of aneurism of the axillary artery must be conducted upon the same general principles that direct the management of the disease in other situations. These have been discussed in the article *Aneurism* (q. v.), and need not be repeated here. We have already observed, that a spontaneous cure is occasionally effected, and we have, besides, quoted a case from Sabatier, in which a false consecutive aneurism was effectually remedied by the method of Valsalva. Another instance, in which the disease was cured in a similar manner, has been reported by Pelletan; but when we consider the fatal tendency of the disease, and the numerous obstacles to success, either under the unassisted powers of nature, or the ordinary means of art, exclusive of the ligature, we should be cautious how far we confide in feeble and temporizing measures. When the resources of surgery were more limited, the treatment of axillary aneurism consisted for the most part in the rigid employment of antiphlogistic means, according to the method of Valsalva, and when these failed, amputation at the shoulder joint was resorted to as a last refuge. But the triumphs of art having long since demonstrated, that even the large arterial trunks may be safely and securely included in a ligature, for the cure of aneurism, and the arrest of hemorrhage, there are few circumstances that would justify a reliance upon any course of treatment, to the exclusion of the operation, and none, perhaps, to authorize amputation at the shoulder joint. We have quoted a case above, it is true, in which Larrey resorted to this latter expedient, and Debaig has reported another; but if it in these cases afforded the only chance, it was because of the neglect of the ligature at the proper season, by which the tumour was allowed to increase to such an enormous size, as to render it difficult, or impossible, to reach the artery. If, therefore, amputation ever becomes necessary, it is under such circumstances, and the surgeon who would allow the disease to advance thus far, would justly merit to be censured for his negligence, unless impelled to such a course by the misguided fears, or the obstinacy, of the patient. It should be constantly borne in mind, that the safety of the patient depends upon the vessel being secured above the aneurism, either below or above the clavicle, and that the longer the operation is deferred, the greater will be the difficulties of achieving it with success. If the aneurism be situated low down, it will rapidly attain such a size, as

to render it impracticable to apply the ligature below the clavicle; and as the same cause will force the clavicle upwards, if the operation be too long delayed, this displacement will become so great, that the artery cannot be reached between the clavicle and the scaleni muscles.

These considerations strongly indicate the importance, in all cases of axillary aneurism, of resorting early to the ligature. The obstinacy of the patient alone, some peculiar condition of the constitution, or of the parts affected, contraindicating an operation, can justify any other procedure. Under these circumstances, the general treatment may be confided in, but seldom can we indulge in any sanguine hopes of success,—and if the tumour be allowed to become so diffused, or the clavicle so much displaced, as to render the application of the ligature impracticable, we question much whether amputation would better the condition, since the artery is diseased so far above the level of the articulation, that we do not know how the hemorrhage could be commanded.

8. *Ligature of the axillary artery.* This may become necessary, either on account of a wound implicating that vessel, or for the cure of an aneurism of the upper portion of the brachial, or the lower portion of the axillary artery. When an aneurism of the brachial artery is situated near the attachment of the latissimus dorsi, the ligature must be applied to the axillary artery; but if the disease be still higher, so as to implicate the latter vessel itself, then the ligature must be applied to it in the claviculo-pectoral triangle, in the space between the upper edge of the pectoralis minor and the clavicle. Finally, if the aneurism extend so high, as to leave no room for the application of the ligature at this point, it must be placed upon the subclavian artery, above the clavicle, and on the outer side of the scalenus muscle. This last operation will be generally demanded, in all cases of axillary aneurism situated on a level with, or above, the pectoralis minor muscle. But as it can be better described in connexion with the region upon which it is performed, although resorted to for the cure of axillary aneurism, we shall refer for all details concerning it, to the article *Cervical region* (q. v.).

It therefore only remains for us to consider the ligature of the axillary artery. There are two points at which it is practicable to secure this vessel. The first is in the fossa of the axilla, below the pectoralis minor;—the second, in the claviculo-pectoral triangle, between the upper edge of that muscle and the clavicle. The portion of the artery which is covered by the pectoralis minor might also be tied; but as it would be necessary, in the performance of the operation, to cut the pectoralis minor across, and as, besides, the principal thoracic branches are given off near it, the vessel is never tied in this situation. The second point only is available, when the condition calling for the ligature is an aneurism occupying the axilla, except when it is determined to tie the vessel on the distal side of the tumour, as was practised in one case by Dupuytren. But when an aneurism of the brachial artery is situated so high, as to leave no room for the application of a ligature upon that vessel, the axillary artery may be tied at the first point indicated.

Cases in which a ligature was applied to the axillary artery by Hall, White, Desault, and others, on account of wounds, have been already mentioned. The individual upon whom Hall operated recovered; but White's case terminated fatally by gangrene;—an event which was scarcely avoidable, on account of the rude operative procedure adopted. A needle, armed with a ligature, was plunged deeply through the soft parts in the axilla, with the object of including a portion of the surrounding structures in the knot. On examination after death, it was found that three of the chords of the axillary plexus of nerves were tied up with the artery, and that the vein was wounded. (Bell. *On Wounds.* 3d edit. p. 60.) Desault's case promised at first to be more fortunate; but erysipelas seized upon the shoulder and arm on the fourth day, and the patient was finally destroyed by gangrene. Pelletan made an ineffectual effort to secure the axillary artery below the clavicle, on account of a large axillary aneurism. He at first proposed to detach the pectoralis major from the clavicle, and turn it downwards; but being persuaded that the aneurismal tumour, in being deprived of the support afforded by this muscle, would be apt to burst before the ligature could be applied, he resolved to include a portion of the fibres of the pectoral muscle in the ligature; but after plunging an armed needle repeatedly through the parts, without securing the artery, he desisted, and the individual died on the twentieth day after the operation. (*Clinique Chirurgicale.* II. 49.) The first case in which the axillary artery was successfully tied, on account of aneurism,

was one on which the operation was performed by KEATE. The aneurismal tumour had already ruptured, and the hemorrhage was commanded by pressure upon the first rib. An incision was carried obliquely through the pectoral muscle, so as to expose the artery, and a curved blunt-pointed needle, armed with a double ligature, was passed, as was supposed, beneath the vessel. On drawing it, however, the artery still pulsated, and a second ligature was passed nearer the clavicle, which being carried deeper, commanded the vessel. In a few days, the swelling of the arm began to subside; the wound suppurated; and the ligatures came away with the dressings. The arm finally regained, in a great measure, its power of motion, and recovered its feeling. (*Med. Review and Magazine*, 1801; and Art. *Aneurism*, in COOPER's *Surg. Dict.*)

Since that period, the axillary artery has been tied beneath the clavicle in other instances. The operation was performed successfully, in 1815, by CHAMBERLAINE, of Kingston, Jamaica, on account of traumatic aneurism of the axilla (*Med. Chirurg. Transact.* VI. 128.); and more recently, ROUX applied a ligature to the axillary artery below the clavicle, on account of an aneurism occupying the lower part of the axilla. (BÉRARD. *Dict. de Méd.* IV. 497.) The volume of the tumour subsided promptly, and the patient recovered. To these cases, should be added two others,in which it is stated by GUTHRIE, that the patients died under the attempts to apply the ligature, the vein being injured in both instances. (*Op. Cit.* p. 265.) It is not mentioned, however, for what purpose the operation was performed, whether for aneurism, or wound of the artery. The same remark may be made in reference to two other fatal attempts of the same kind;—one mentioned by ROUX, as having happened at the Hôpital Beaujon; the other by DELPECH. In 1829, DUPUYTREN applied a ligature to the axillary artery, on account of an aneurism of the subclavian, situated above the clavicle. The ligature was applied between the tumour and the capillary vessels, according to the method of BRASDOR; but the individual survived only nine days. (*Leçons Orales de Clinique;* and *Lond. Med. Gazette*, XII. 857.)

The operation of applying a ligature to the subclavian artery above the clavicle, and on the outer side of the scalenus muscle, has been far more frequently performed, and should be preferred in all cases of axillary aneurism. As, however, the method of operating in that situation will be described in the article *Cervical region*, we shall only describe here the method of tying the axillary artery, below and above the pectoralis minor muscle.

Ligature of the axillary artery in the outer third of its extent. — LISFRANC's *Method.* — In this operation, the artery is exposed in the hollow of the axilla. It is applicable to those cases of aneurism of the upper portion of the brachial artery, in which sufficient space intervenes between the tumour and the pectoralis minor, to admit of the application of a ligature;—also to wounds of the corresponding portion of the vessel.

The patient is placed upon his back, and the arm forcibly extended from the body. The space between the latissimus dorsi and the pectoralis major being divided into three portions, a longitudinal incision, of about three inches in length, commencing on a level with the head of the humerus, is carried along the line corresponding to the union of the anterior with the middle third of the space mentioned above. The skin and cellular tissue being thus divided, the axillary plexus and the median nerve are brought into view, with the artery immediately beneath the latter. Having advanced thus far, the artery is cautiously isolated from the vein and nerves, using the scalpel or bistoury as little as possible, and the ligature passed from behind forward, by a common aneurism needle. (COSTER, *Manuel des Opérations Chirurgicales*, p. 30. Paris, 1835; and OGIER and LOGAN, *Compend. of Operat. Surg.* Part II. p. 35. pl. vii. Charleston, 1835.)

Ligature of the axillary artery between the clavicle and the pectoralis minor. A variety of procedures has been proposed for the performance of this operation. CHAMBERLAINE made two incisions; one along the lower edge of, and parallel with, the clavicle, three inches in length;—the other along the line of demarcation between the deltoid and pectoralis major, which intersected the first, near its middle. In this manner, a small flap was formed, which was turned downwards. DESAULT and ROUX recommend an incision to be made on the inner side of the coraco-deltoid line,—then the division of the pectoralis major upon a grooved directory; and, finally, the division of the pectoralis minor where it reposes in front of the artery. This is the most difficult,

and certainly the most objectionable procedure of all that have been advised. The following methods are far preferable.

a. HODGSON'S *Method*. The patient being seated on a chair, with the shoulders inclined a little backwards, an assistant, standing behind, compresses the subclavian artery where it runs over the first rib. The operator makes a semilunar incision, with the convexity downwards, commencing about an inch from the sternal extremity of the clavicle, and extending outwards four inches, to the line between the pectoralis major and the deltoid. The first incision divides the skin and cellular tissue; a second, of the same extent, and carried in the same direction, traverses the fibres of the pectoralis major. The semilunar flap, thus formed, being dissected up, the pectoralis minor is exposed, above which the artery can be felt pulsating, having the vein below, and when full, somewhat in front, and the axillary plexus behind, with one of its chords in contact with the vessel. The artery being then isolated by means of a blunt instrument, the ligature is passed beneath it, and tied. (*Op. Cit.* II. 105.)

No possible advantage can result from giving the incision the curved direction here indicated, and the operation has, besides, been objected to, on account of the necessity it incurs of sacrificing so large a portion of the fibres of the pectoral muscle. GUTHRIE remarks, moreover, that it is so extremely difficult, that he had known two individuals die under the attempt to pass the ligature.

b. *Method of* CHAMBERLAINE, LANGENBECK, RUST, CHELIUS, MANEC, &c. To this head may be referred several operative procedures, which, though differing in some slight particulars, are nevertheless founded upon the same general principles. CHELIUS proceeds in the following manner: the patient is seated, with the shoulders drawn backwards, while an assistant compresses the subclavian artery over the first rib. An incision, commencing an inch from the sternal extremity of the clavicle, is carried outwards below the lower part of that bone, towards the coracoid process, to the furrow which separates the pectoral from the deltoid muscle. The skin and cellular tissue are first divided,—then the fibres of the pectoralis major, and the pectoralis minor is brought into view. The point of the finger, inserted between the coracoid process and the lower edge of the clavicle, discovers the artery, together with the brachial plexus. The vessel is cautiously separated, and the ligature passed beneath it by means of DESCHAMP'S aneurism needle. (CHELIUS. *Handbuch der Chirurgie.* I. 875.) LANGENBECK'S procedure only differs from this, in the incision being commenced beneath the central part of the clavicle. (*Nosologie und Therap. der Chirurg. Krankheiten.* IV. 221.) RUST makes an incision two and a half inches in length, and one fourth of an inch below the clavicle, which is carried obliquely outwards towards the tip of the coracoid process. By this incision, one half the clavicular portion of the pectoralis major is divided, together with the tendon of the pectoralis minor. This latter step of the operation is altogether superfluous. BUJALSKY and MANEC, with the view of avoiding the cephalic vein, which runs in the furrow between the pectoralis major and the deltoid; recommend the incision to be commenced at that point, and carried inwards.

c. MARJOLIN and LISFRANC'S *Method*. The patient being properly placed, in either a sitting or a recumbent posture, an assistant compresses the artery as above, and the arm is carried outwards and backwards, in order to put the pectoral muscle on the stretch. The operator, searching for the depression corresponding to the line of separation between the clavicular and sternal portions of the pectoralis major, commences an incision half an inch outwardly from the sternal extremity of the clavicle, which is carried in the direction of the line indicated, to the extent of three inches. The two portions of the pectoral muscle are then separated in the direction of their fibres, from one end of the incision to the other, and if no natural line of demarcation can be perceived, the knife must be carried between the fibres. This done, the arm is brought down to the side of the body, in order to relax the muscle, and give greater extent to the aperture. Near the inner third of the sternal extremity of the clavicle, the vein is found in front of the artery, which is often covered with a considerable quantity of adeps and cellular tissue. Care must be taken, not to injure this vessel; and to avoid this, it will be advisable to isolate it with the handle of the scalpel, the finger-nail, or the point of a directory; after which, the ligature is passed from below upwards. (COSTER. *Op. Cit.* p. 30.) This last step of the operation will be greatly facilitated by the use of some one of the ingenious contrivances which have

been devised within a few years, for passing a ligature beneath deep-seated arteries. (See *Ligature*, and *Cervical region.*)

It is of but little consequence, which of the two last procedures be adopted. Each has its advantages and disadvantages. The method of LANGENBECK and CHELIUS affords greater facility in reaching and securing the vessel; but it is liable to the objection of sacrificing the fibres of the pectoral muscle. MARJOLIN and LISFRANC'S method is not obnoxious to the last inconvenience; but it gives rise to greater difficulty in securing the vessel. When the aneurism is not so large as to occasion great protrusion beneath the pectoral muscle, and the clavicle so long as to throw the shoulder well back, it should be preferred; but under other circumstances, the method of LANGENBECK and CHELIUS, as modified by BUJALSKY and MANEC, should be selected,—especially as the division of the fibres of the pectoral muscle is of comparatively little moment, when put in competition with the risk of injuring the axillary vein and nerves in attempting to pass the ligature in the method proposed by LISFRANC.

After the ligature is drawn, the lips of the wound are brought together in the usual way, and the subsequent treatment conducted upon the general principles laid down in the article *Aneurism* (q. v.). The circulation is carried on through the collateral vessels, — especially through the free anastomoses between the supra scapular, transverse cervical, and subscapular branches.

As regards the application of the method of BRASDOR, of tying the artery on the distal side of the tumour, to this vessel, a sufficient number of facts have not been collected to justify any conclusion. It should, of course, only be resorted to when the aneurism is situated so high as to render it impracticable to tie the subclavian between, or on the outer side of, the scaleni muscles. The case in which DUPUYTREN performed this operation, it has already been stated, terminated fatally.

BIBLIOGRAPHY.—The several treatises on Surgery, and the bibliographical record under *Aneurism* and *Arteries.*

9. *Aneurismal Varix of the Axilla.* It was remarked above, that a wound inflicted upon the axillary region, might implicate the artery and its corresponding vein, in such a way as to establish a communication between them, and lead to the development of an aneurismal varix. Whenever such communication is established, the artery projects its blood, with great force, through the solution of continuity into the vein, and the coats of the latter being too yielding to resist the distending influence of the column of blood, it becomes dilated into an aneurismal varix of variable magnitude, which may even extend some distance down the arm. The characters of this form of disease having been furnished in the article *Aneurism,* it will be sufficient at present, to indicate a few cases in which it was developed in the axillary artery, and in consequence of injuries inflicted upon this region. Two cases of this kind have been reported by LARREY. The first was an invalid, in whom an aneurismal varix supervened upon a sword-wound of the axilla. The whole of the veins of the arm became so much dilated, that when the member was suffered to hang by the side, the whole of them were rendered turgid, and those which were most prominent were affected with pulsations isochronous with those of the arteries. (*Mém. de Chirurg. Militaire.* IV. 341.) Another instance, still more interesting, fell under the observation of the same individual. A grenadier received, in a duel, a sabre-wound, which penetrated near the attachment of the sterno-cleido-mastoid muscle of the left side, ranged obliquely, and divided a portion of that muscle, the scalenus, the subclavian artery and vein, and probably also a greater portion of the brachial plexus. An alarming hemorrhage took place immediately; the patient reeled, and fell to the ground in a state of syncope, in which he remained for some time, apparently dead. The assistants made pressure in the situation of the wound, and employed means to restore animation. When LARREY saw the individual on the succeeding morning, he was as cold as marble, and presented every indication of approaching death. The hemorrhage, however, had ceased; but the clavicle was effaced by a considerable tumour, which was manifest both above and below it, and pulsated isochronously with the artery. There was also a singular rustling sound along the course of the axillary vein, analogous to that produced by the passage of water through a tortuous metallic tube. The arm was cold, senseless, motionless, and without pulse; and the pulsation of the other arm was small, nervous, and scarcely perceptible. The edges of the wound were drawn together by adhesive strips, over which were applied cloths wet with cold camphorated wine. In the evening, the jugular vein

was greatly distended, and pulsated;—next morning, the pulsation of the tumour had increased, and on the day following this, the pulsation of the jugular had become so great, associated with evidences of strong cerebral determination, that it was opened, with the view of emptying the vessels of the brain. The blood was thrown out in jets, and exhibited all the characters of arterial blood. By the eighth day, the wound was cicatrized; the veins of the arm became distended on the tenth day; the heat and sensibility were restored as far down as the elbow; and pulsations were perceptible in the cephalic vein. By the twentieth day, the tumour had entirely disappeared; but the rustling sound, and the pulsations of the veins of the neck and arm, continued. The arm, however, gradually regained its powers, and by the fifty-fifth day, slight pulsation was perceptible in the radial and ulnar artery. (LARREY. *Clinique Chirurgicale.* III. 139. Paris, 1830.)

A third case has been reported by DUPUYTREN. The accident took place in a young man who was wounded with shot, the latter implicating the axillary artery and vein. In this instance, there was a peculiarity, which though previously noticed by SCARPA, does not generally exist in aneurismal varix. Besides the great dilatation of the vein resulting from the communication established between it and the artery, there was also a false consecutive pulsating aneurism, situated between the two vessels. (DUPUYTREN. *Traité des blessures par armes de guerre*, &c. II. 78. Paris, 1834.)

The *treatment* of aneurismal varix must be regulated by the circumstances of the case. Often, there is not sufficient inconvenience experienced, or danger incurred, to call for a difficult and dangerous operation. Cold, with astringent, slightly exciting, lotions, to the part, in the early stage of the disease, and properly regulated support, maintained by a compress and bandage, will generally suffice to prevent the rapid progress of the disease, and will sometimes effect a cure, or so mitigate the morbid condition of the veins of the arm and axilla, as to destroy the principal source of uneasiness and apprehension. Should the aneurismal varix, however, become very large, so as to interfere with, or destroy, the use of the limb; or should there be associated a false consecutive aneurism, disposed to terminate unfavourably, — then an operation cannot be dispensed with. This should be done, by making an incision upon the artery, above and below the tumour, and securing it in each situation, so as to leave the aneurism untouched. (See *Aneurism.*)

E. GEDDINGS.

AXILLARY. Appertaining to the axilla.

Axillary Artery, a continuation of the subclavian, comprised between the inferior margin of the second rib and the outer edge of the fold of the arm-pit. (See II. 565, and II. 344.)

Axillary Vein, a continuation of the brachial veins; it corresponds to the axillary artery. (See II. 566, and *Veins.*)

Axillary Nerve, a branch of the brachial plexus. (See II. 567, and *Nerves.*)

Axillary Glands, lymphatic glands of the arm-pit. (See II. 567, and *Lymphatics.*) I. H.

AXIS. (From αξων, axis.) A right line passing through the centre of an object. It has also been applied to the second vertebra of the neck, from its being a kind of axis upon which the head turns. I. H.

AXUNGIA. (See *Fat.*)

AZEDARACH. (See *Melia.*)

AZOTE. (From α priv. and ζωη, life.) Thus named because supposed to be destructive of life. It possesses, however, no positively deleterious qualities, though incapable of supporting life. (See *Nitrogen.*) I. H.

AZYGOS. (From α priv. and ζυγος, equal.) Unequal, without a fellow. Several single parts are so denominated.

Vena azygos. (*Veine prélombo-thoracique.* CHAUSSIER.) This name was given by GALEN to a vein which arises from the inferior vena cava or one of its branches, and passing up on the right side and anterior part of the spine, terminates in the superior vena cava where it penetrates the pericardium.

Semi azygos. (*Veine petite prélombo-thoracique.* CHAUSSIER.) This vein passes up on the left side of the spine, and presents in miniature a similar arrangement to that of the vessel just noticed.

Azygos muscle, a muscle of the *uvula* (q. v.).

Azygos process, a process of the sphenoid bone. (See *Bones.*) I. H.

END OF THE SECOND VOLUME.